HANDYBOOKS FOR HANDICRAFTS

THE PATTERN MAKER'S HANDYBOOK

HASLUCK

PRICE 2/-

CROSBY LOCKWOOD & SON.

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THE

PATTERN MAKER'S HANDYBOOK.

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A Practical Manual

ON

PATTERNS FOR FOUNDERS:

EMBRACING INFORMATION ON THE TOOLS, MATERIALS AND APPLIANCES EMPLOYED IN THEIR CONSTRUCTION.

BY

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WITH UPWARDS OF ONE HUNDRED ILLUSTRATIONS.

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PREFACE.

THIS handybook is intended to afford some information on pattern making, and also some insight of the processes to which the patterns are to be subsequently subjected, as a knowledge of these is essential to enable a pattern maker to labour to the best advantage.

The literature of this subject is but scanty; the cause may be that this intricate art is one that cannot be conveniently brought under well-defined rules. Almost every fresh pattern that is made requires some amount of independent thought from the artificer. This handybook is intended to be especially useful to the beginner. The general information it contains, and the glossary of terms, may make it handy even to practised hands of wide experience.

LONDON, *July*, 1887. P. N. HASLUCK.

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THE

PATTERN MAKER'S HANDYBOOK.

CHAPTER I.

PATTERN MAKING.

THE patterns on which this handbook treats are those used for forming the moulds in which metal castings are made. Any mechanic may find it necessary to make a pattern, some time or other, to replace a broken casting or to carry out his own ideas when pattern makers are not get-at-able for odd jobs in busy times.

Pattern making is of endless variety. In this business a piece of work may be turned out to-day, the like of which was never before seen nor imagined, and which may never be required again. It is an art which takes in all manner of shapes and sizes. A good pattern maker is always learning, and he must think for himself to supply the demands that are constantly being made upon his ingenuity by new forms and fresh devices. To take any pattern, and explain its construction would be of little advantage, because of the dissimilitude of forms which have to be dealt with. However, there are certain operations or processes, not very numerous, which the pattern maker has at command, adapted to the peculiarities of the material in which he works. All patterns are alike in that they are the result of these processes: and, however diversified their forms,

they are with rare exceptions, but different combinations of straight lines and circles.

Patterns are mostly made of wood, although brass and iron are also common, especially when large numbers are required. A pattern nearly always represents the appearance and dimensions of the casting as far as its external surface is concerned. This is also frequently true of its internal surface, but not invariably so, dry-sand cores made apart from the pattern being often introduced to form the cavities and internal spaces required. Patterns are sometimes made in two or more pieces fastened together by pins or dowels, the object being to facilitate their removal from the sand.

For the larger and heavier class of metal patterns, cast-iron is used as they are not often fitted up with gates in a board or spray. It is difficult to join iron patterns to gates, as they will not easily solder, and therefore require to be lapped and riveted together. A white metal consisting of two parts lead and one of tin is very generally used and is very easy to work. For brassfounders a mixture of copper and tin is considered the best.

When making patterns for the foundry it is necessary to bear in mind the process of moulding, otherwise it is very probable that patterns will be turned out which cannot be manipulated in the sand. In the second chapter will be found a brief sketch of the process of moulding. The tyro should follow directions as nearly as possible, and so reduce the possibilities of error to a minimum. Castings shrink on cooling, so that patterns ought to be made slightly larger than the rough casting is wanted to be; but in small work the shrinkage is practically inappreciable. The size and shape of a small casting is far more likely to be altered and distorted by being knocked about in the mould, when loosening it from the sand.

All those parts which in the casting have to be smoothed up by turning or filing must be left stout enough to bear the reduction, and this must be specially adhered to when making patterns of thin things which require smoothing on both sides. The cost price of a little extra metal is nothing compared with the absolute necessity of having a sound casting; and it is a pity that this fact is often forgotten. The thirty-second part of an inch makes all the difference between useful and useless castings of small model engines, if the thickness is increased or diminished by that small amount. It is very easy to remove a surplus thirty-second or sixty-fourth of an inch of metal from the casting, should it be requisite.

All patterns should have a little clearance to facilitate their removal from the sand. In order to effect this, see that the angles are all a trifle obtuse; on no account may they be under-cut. After being turned, patterns are all the better for being smoothed over with fine glass-paper, and afterwards varnished with shellac varnish, or brown hard varnish, into which a little colouring pigment has been put, to give them a workmanlike appearance.

Any hard wood will do for making patterns, which must be smoothly finished and varnished, so as to insure good castings. Rough patterns destroy the moulds, and useless castings generally result; an extra half-hour judiciously spent in perfecting the patterns will often save half a day's extra work in fitting up the castings.

Wood for patterns is best when suitably seasoned, and time is the best seasoner; so use that which is aged. Nearly all kinds of wood are used in making patterns. Large, long and flat patterns are constructed of white or yellow pine, on account of its lightness, cheapness and freedom from warping and splitting but it has the disadvantage of being soft, and so liable to receive injury when made up. Choice Canadian red pine is harder,

but should be selected as free from knots and turpentine as possible. Still harder is white American fir, or spruce, which is very suitable for large patterns. Teak is light, strong and durable, also easily worked, but it wears the tools a little, and is somewhat liable to split. Any part of a pattern which has to be turned may be made of beech; which has an uniform grain. Plenty of elm, oak, maple and sycamore is also used.

In choosing material for a pattern we must consider its quality to keep its shape when formed; its strength to withstand the strains of rapping, and the general usage of a foundry and its ease of manipulation and its cheapness.

Deal and pine are generally chosen as filling these conditions the best for general work; but where extra strength is required, owing to the delicacy of the pattern, or the great number of castings required of it, either mahogany or cherry is chosen.

In small standard patterns, iron or brass is used, first making a pattern of pine. Small, stiff patterns are best made of brass, and also their gates, because the surface keeps smoother than that of iron, and the joints are easily soldered.

In selecting wood for patterns it requires to be straight-grained, well-seasoned and free from knots or shakes. Choose the soft, yellow, close-grained and light wood, slightly resinous, rather than the dry, hard, nut-brown fibre, with the grain strongly defined. The former withstands the action of the temperature and moisture of the atmosphere better than the latter, and so is less liable to warp or change its outline.

Yellow pine is particularly suitable for pattern making, it is a North American tree, and grows in immense numbers in the region from Virginia to Canada. In the valleys and near the banks of rivers, where the soil is rich and soft, the tree reaches its grandest proportions, growing often to a height of

from 170 feet to 180 feet, and from 4 feet to 5 feet diameter at the base. The trunk of this tree tapers but slightly, and is entirely free from limbs or branches for over two-thirds of its length.

Though we call this wood American yellow pine, it is called by the Americans themselves white pine, not so much from the colour of the wood as the colour of the bark. It is known also amongst us as Weymouth pine, from the fact of Lord Weymouth having, in the last century, planted large numbers of these trees in Wiltshire. The utility of the wood in the hands of the pattern maker is that which concerns us most. This pine was introduced into this country as an article of commerce early in the present century, and has now taken the place of Baltic timber, once used for the same purposes. An examination of the interior of pieces of furniture made previously to the above date will show the wood to be what is now called white or red pine, a wood full of resin and small hard knots. A large proportion of the wood of that period is called Memel, being shipped from a port in the Baltic of that name. It is to be noted that almost all woods imported into this country, whether American or European, are known by the ports from which they are shipped. How different, and how much more pleasant is the task of the modern wood worker with the clean, straight, soft, easily-wrought yellow pine, to that of the workmen of sixty or seventy years ago, who had to contend against a hard, reedy, knotty, resinous wood, in narrow widths that required numerous joinings, and was ever twisting and shrinking. The house joiner was no better off, as may be seen by examining an old house, where the floors and finishing are of the red pine, or Memel, in narrow widths and having innumerable knots. Our principal supply of yellow pine has for a number of years been from St. John, New Brunswick, though much valuable timber is shipped from other

ports. Some is shipped in the form of squared logs, and is cut up into boards after reaching this country. Very much yellow pine is now imported in the form of deals, these being sawn, before embarkation, into deals or planks of from seven inches to twenty-four inches broad and three inches thick, and usually from twelve feet to twenty feet long. The quality of the timber is more easily discernible, and they are picked and classed as firsts, seconds, thirds, etc. They are sawn at the mills into boards of the various thicknesses, to suit the requirements of trade, from one-eighth of an inch upwards.

Experiments show that felled wood when green contains about 45 per cent of its weight in moisture. Timber felled in winter holds at the end of the following summer more than 40 per cent of water. Wood kept for several years in a dry place retains from 15 to 20 per cent of water. Wood that has been thoroughly kiln-dried will, when exposed to the air, under ordinary circumstances, absorb five per cent. of water in the first three days, and will continue to absorb until it reaches from 14 to 15 per cent., the amount fluctuating above or below this according to the state of the atmosphere. It will be evident from the above statements that wood, however dry, is still subject to change, and that even if kiln-dried, it requires to be stacked in a dry place until it settles to the natural conditions of seasoned wood.

To season timber for pattern work, it should be stacked where it will receive a free circulation of air, and have an extemporised roof to protect it from the sun and rain. Four years are requisite to season wood sufficiently to be fit for general pattern work. A careful pattern maker will generally have for special and particular work a store of wood, twenty to thirty years old, in good preservation, and which had perhaps been previously used in an old pattern or building.

Straight-grained pine will not shrink end-wise perceptibly,

but across the grain it is always liable, however dry, to swell and to shrink according to the humidity of the atmosphere. For this reason wood should not be glued together with the grain of one piece crossways to the other. The sap wood, or outer part of the tree, will shrink more than the heart, hence a whole tree will always split in drying. From this it is evident that particular attention is necessary to the choice of boards for certain work, and in gluing together, so that strains be equalised, and so tend to keep the structure in better shape. In gluing up a solid block, for instance, by placing the boards with the heart side of the wood on the outside, the pores on the sap side are by this means protected and the tendency of the exposed joint is to keep closed, thus counteracting the strains.

There is another difficulty in this condition of contraction, which relates to the curving of the wood lengthwise. When the grain is not perfectly straight—that is, if the tree is crooked, and a straight board is sawn from it—one part of the board will have more heart wood than the other. The sap part will contract more than the heart, and, as a result draw the board crooked lengthwise. This curly and cross-grained board is the wood we hear of that contracts endwise.

In constructing patterns, the fact should always be taken into account that wood, however dry, is subject to this change to some extent. Well-seasoned wood varies at the rate of one-tenth of an inch to the foot in width between the temperature of the pattern shop and that of the foundry. Patterns that have been correct the first day of casting may become too large subsequently. Not considering this point in the construction of a pattern, and neglecting to make proper allowance, is a common source of great trouble and bad work. Too much importance cannot be laid upon this consideration, as it arises in almost every description of pattern that is made.

The best, cheapest and most effective way to meet this difficulty is by a framed construction using the wood lengthwise of the grain to keep the essential sizes or outline of the pattern, and leaving open joints so as to allow the wood freedom to expand or contract across the grain, and yet not effect the essential sizes. Take a piece of wood twelve inches square and an inch thick, to illustrate this principle. Cut oft a piece from a planed board of that thickness, and this will not keep even-flat unless a batten is put across it. When this has been done, it will keep twelve inches long, but not twelve inches wide: it may not take a week to get to eleven and seven-eighths of an inch. The batten will keep it flat; but will not be able to resist the force with which it will shrink. If it be desired that it should keep to size, recourse must be had to panelling, which is managed as follows:—Take four pieces one inch thick, about one-and-a-half inch wide, and twelve inches long, with ends cut to a mitre. Plough a groove on the inside of each piece. These four pieces, when joined, will form a frame. A filling for the centre must now be got out and tongued to fit the grooves it is to be put in, before the last piece of the frame is fixed in its place. In large work, the panel, or centre filling, is made up of several pieces, so that the whole shrinkage is divided among them; otherwise the panel may shrink quite out of the grooves.

For small patterns the Germans use cherry-tree wood, well-seasoned, which is hard and close-grained; but in England mahogany (chiefly baywood) comes into use for all small work. In fact it will suit nearly all patterns; it warps less than any other wood, and shrinks very little in drying. It can be worked at the ends easily, and its corners keep sharp when worked with good sharp tools.

To be a competent pattern maker a knowledge of practical plane and solid geometry and also of mechanical drawing are

required as much as, and perhaps more than, by the draughtsman, as the former is required to lay upon an uneven surface lines which are much more easily got upon flat paper. A knowledge of the nature of woods, or other materials used is necessary, and the pattern maker must be able to construct, with accuracy, any conceivable shape of body, so that it will stand the strains of the work required, and keep its size. He must understand how it can best be moulded, as he is required to decide how much of a pattern is necessary, where to make the parting, the taper, the prints, the cores, &c., and to make loose pieces accordingly.

A skilful pattern maker helps the moulder to make the mould that is necessary for the required casting; therefore the capacity of the moulder and his appliances must be known. Some moulds can be made cheaper without a pattern by the use of strikes; others with a combination of strikes and parts of patterns; others with cores; while others require a full pattern of the size and shape of casting required, with allowance for shrinkage.

Thus a casting may be made to cost more in the pattern making, and less in the moulding, or more in the moulding, and less in the pattern making, according to which method would do the work cheapest. The probable number of castings required is a first consideration in the construction of a pattern and the finish required. If twenty castings be required from one pattern, and one hour's more work on the pattern would save the moulder five minutes on each mould, there would be an economy of forty minutes saved by the extra hour spent in pattern work. If but one casting were to be made, and one hour's extra work were still put upon the pattern, there would be a loss of fifty-five minutes, seeing that the moulder was saved but five minutes' work.

After the pattern-maker has considered the requirements of

the moulder, he must think of the casting in the machine shop, and consider the shrinkage, the finish, and the parts that require to be most sound. Bearing all this in mind, he must make his pattern accordingly. A wide range of thought, skill and experience are necessary for efficient pattern making.

Cast iron, in common with nearly all other metals, contracts in cooling from the molten state in which it enters the mould. Patterns have, therefore, to be made larger by this amount than the castings are intended to be. In order to always make this allowance, the pattern maker uses a rule, which, though called a foot-rule is actually about twelve and an eighth inches long. Such a rule should never be applied to a drawing, for then the necessary allowance would not be made, mistakes may be sometimes made through doing this.

Some men are opposed to shrinkage-rules, and have some reason; because it is a fact that different kinds of iron do not contract the same amount; that hard, or white iron, will contract more and scrap iron less than soft grey iron. Another point is that heavy, massive castings will strain the mould to such an extent as to almost nullify the shrinkage.

For machine castings a shrinkage of one-tenth of an inch per foot is nearer the truth than one-eighth of an inch. By comparing many long columns, pipes, &c., with their patterns, it was found always that one-tenth of an inch was enough, and sometimes more than enough. But close observation also showed that the length of a ten-feet or twelve-feet column could not be depended upon within a quarter of an inch, it frequently happened that two columns cast from the same pattern would vary that amount in their lengths.

Shrinkage is not allowed on measurements of four inches and under, as the rapping of the pattern will enlarge the mould enough. Broad, heavy castings, usually turn out thicker than their patterns; one and fifteen-sixteenths of an inch of pattern

will give two inches thickness of casting; and two and seven-eighths of an inch pattern will appear as three inches in casting.

For the parts of a casting that are to be finished, allowance must be made in the pattern of the amount necessary to true it up, which depends upon the liability of imperfection in the shape of the casting. It must also be so moulded that the metal shall be clean and sound in the places to be finished. To this end such parts should be arranged to be cast down, or in the position in the mould where the metal receives the greatest pressure first, thus floating the impurities in the metal away from these parts. When the whole surface of a casting is finished, extra finish is allowed on the top side of the mould and the rest is left to the moulder, who uses skimming gates and an extra clean mould, and sometimes a rising head, thus adding a pressure of feed to the precaution of cleanliness.

The allowance that should be made for shrinkage of castings when cooling, and for finishing them, are of the first importance, because they are questions that arise with reference to almost every pattern or casting made. The adoption of a contraction-rule seems to dispose of the question of shrinkage in the minds of most pattern makers, and when in certain cases the allowance does not prove correct, they will still stand behind their rule, considering themselves responsible no further. All patterns larger than three or four inches should be measured with a contraction-rule, now purchasable, and made in steel as well as wood. The contraction foot-rule is about the eighth of an inch longer than the standard foot; but still more than this must be allowed in a wood pattern, if the casting is intended for an iron pattern, say for a blank to be turned up; in this case judgment must be exercised.

A good pattern maker is conspicuous chiefly in the ability to judge correctly upon all the phases which arise, this mental part being of first importance; while the physical is secondary,

especially in this age of machinery. The allowance necessary for shrinkage varies for different kind of metals, and the different conditions under which they are cast. For castings where the thickness runs about one inch, cast under ordinary conditions, the following allowances can be made :

For cast iron	$\frac{1}{10}$ in.	per foot.
„ mal. iron	$\frac{1}{8}$ in.	„
„ brass	$\frac{3}{16}$ in.	„
„ steel	$\frac{1}{4}$ in.	„

Thicker castings, under the same conditions, will shrink less, and thinner ones more than this standard. The quality of the iron, and the manner of moulding and of cooling will also make a difference. Where there is a large range of work, the shrink-rule is often discarded, and the judgment and experience of the pattern maker substituted.

When heavy and light parts occur in one casting, it will cause unequal shrinkage, which will crack the casting or draw it out of shape, or weaken it by the unequal strains existing within itself. A good illustration of this is found in an ordinary pulley with straight arms.

Generally speaking, all patterns should be "drafted," that is, tapered so as to draw from the mould. Thus is seen the necessity of deciding how the pattern is to be moulded before commencing to make it, so as to have the draft in the right direction.

It seems to be generally conceded that one-sixteenth of an inch, on all sides, for one foot of depth shall be the amount allowed, and though this may be taken as the rule, deviations are frequently made on both sides of it. The hubs and rims of wheels, and the ribs on machine framing, though shown parallel on a drawing, are always cast with a good deal of taper. Where extra draft does not interfere with the designs, about an eighth

of an inch in three inches is a fair allowance. On the other hand, the teeth of spur-wheels and of pinions are made almost square; the draft being so little that it cannot be detected in the castings. The pressure of iron being greater at the bottom of the mould than at the top causes a slight expansion of the mould, thereby neutralising the draft. Sometimes the teeth in the casting are found to be larger on the bottom side than the pattern teeth were on the top side.

Core boxes that cannot be taken apart, require at least one-thirty-second of an inch draft for every three inches of depth. If less be given the core cannot be relied upon to shake cleanly out of the box. If there are narrow or intricate places in the box, more draft must be allowed in those parts. The least that the core-maker can work with is named, but where extra draft does not act detrimentally it is well to give more, even to as much as three-sixteenths of an inch on all sides for every three inches of depth.

An extra amount of taper must be given to all fixed projections on a pattern that rise into the upper part of the mould. The same is true of any cavity in a pattern into which the cope descends. This extra taper, sometimes called "cope-draft," is necessary because there is no opportunity to rap or loosen the pattern in the mould before the cope is lifted off. The natural adhesion of the sand to the pattern causes portions of the cope to become detached, involving much time, trouble and uncertainty in repairing the mould.

Proper consideration of this matter is of great importance, as it may effect a great saving of time in the moulding shop, without interfering with the draughtsman's designs, or throwing any additional labour on the machinist.

Wood patterns should be painted or varnished before they are put into the moulding-sand. Some woods—oak for example—will draw moisture from the sand and adhere to it, and

the patterns will be difficult to draw. Cedar and deal draw easily even unpainted, but much depends upon the finish. The paint best suited, as a thin coating for patterns, is that made of red lead and a hard drying-oil; sometimes patterns are afterwards blackleaded, or glass-papered, or rubbed with powdered chalk. Pumice-stone also is often used instead of glass-paper, and then a coating of blacklead and beer. The latter may be put on the bare wood if the pattern is fairly finished, and only two or three castings are wanted from it. Hard wood patterns will draw well if coated with copal varnish. Coarse work very often has a coating of common paint. Weak shellac varnish is another protection.

Many men who make patterns follow the cabinet-maker's style, without considering the requirements and usage of the foundry, and take pride in making close joints with nails and glue, so that though the pattern looks well in the pattern shop, it often comes to grief in the mould. A pattern that is right when it leaves the pattern shop is not sufficient; it must be so constructed that it will keep right under the conditions to which it is subjected in the foundry. In large and heavy work these points call for great attention.

To insure the special treatment which is necessary to the different parts of the mould, it is a good practice to varnish with different colours. For example, for the parts that are to be finished or machined bright, use clear or yellow varnish; for core prints, red: and for unfinished surface use lampblack in the varnish. It is very little more work, and it carries its own information. By this means the moulder can see at a glance the parts which require to be clean, where he can use blacking, and the best place to make the air-gate. The same advantage results from a similar treatment of the core-boxes, and for the same reasons.

CHAPTER II.

MOULDING AND FOUNDING.

THE Founders' art is based upon the fusibility of metals and alloys, and affords one means by which they are given the varied forms which fit them for application in the arts. The softer metals and alloys, such as lead, pewter, type-metal, Britannia-metal, and even zinc are usually cast in metallic moulds which are used over and over again. In a more restricted sense moulding is understood to embrace the formation of moulds in sand and loam, which are used for casting metals and alloys fusing above a red heat, as cast-iron, brass, gun-metal, bell-metal, &c. These moulds can be used but once; after pouring and cooling, they are broken up to get out the casting, the sand not being used again.

Pouring the metal for brass and iron castings is accomplished from crucibles or ladles respectively. In large iron-works several ladles, each holding from two to four hundredweight of metal, are often used simultaneously; for still larger masses, crane ladles holding several tons are employed; and when such are insufficient the mould is filled by leader channels direct from the furnace.

The trade of the iron-moulder is distinct from that of the brass-moulder (who also deals with gun and bell-metals), but the methods employed are so nearly identical that in describing the several operations a distinction is not necessary.

Moulds forming the matrix in which an object is cast are made in green-sand or dry-sand and in loam. For the first a

pattern is required; for the last it is generally dispensed with. Moulds are divided into:—Open moulds, into which the metal is poured, the upper surface of the fluid metal assuming the horizontal position. Such are used for ingots and some other objects. Close moulds of metal or plaster of Paris, with ingates by which the molten metal enters. Such moulds are used for inkstands, bullets, type and various other articles made of lead, tin, zinc, and their alloys, which fuse at a moderate heat. Close moulds of sand, in which articles of iron, brass, bronze, &c., are cast. This is the ordinary foundry work, and includes machinery, ordnance, and the multitude of articles of domestic and agricultural hardware. Loam-work in which the mould is built up, instead of being rammed around a pattern. This is used in casting cylinders, tanks, bells, or ordnance of very large size.

Green-sand moulding is the term employed to express the fact that the sand is used in its green or natural state, and is not subjected to any drying or baking process before casting; it is the method followed for the great mass of castings, both iron and brass. The sand for this purpose is kept damp, sufficiently so to form into a compact mass when squeezed in the hand, but it must not be wet, or approach that condition.

The brass-moulder keeps his sand in a trough or bin, over which he works, small castings forming the bulk of his work; but in an iron foundry the whole floor to a considerable depth is formed of old-sand, and on this the surplus quantity for use is heaped together in mounds.

In working from a pattern in green-sand the object in view is to produce in the finely-packed sand a cavity, identical in form with that of the pattern, which is afterwards filled with molten metal and left to cool. To accomplish this the workman is provided with a large assortment of flasks, or moulding-boxes of most various dimensions; they are designed to

hold the sand used in making the moulds. Small flasks are simply rectangular frames resembling ordinary boxes, but without either top or bottom; each part being from 3 inches to 6 inches high. They are connected together generally in pairs (often three or more), by steady-pins, which allow of their separation when full of sand, and their restoration to exactly the same relative positions afterward. Large flasks are provided with cross-bars at suitable distances to prevent the sand, which has been rammed into them, from falling out of its own weight, or rising from the upward pressure of the fluid metal.

The following description will serve to illustrate the principles which govern and guide the moulder working in green-sand. One flask being laid with its lugs uppermost is filled and rammed up with old sand, and stricken off level with the joint of the flask: this is called a false-part. If the object to be moulded has a suitable symmetrical form, the sand in the false-part is cut away roughly, so as to imbed one half of the pattern. Some dry parting-sand is next scattered over the surface. This adheres to the damp sand, and prevents any adhesion between such a surface and any other sand subsequently rammed upon it. After the parting-sand is blown off the exposed part of the pattern, the other side or drag is put on, its steady-pins entering the holes in the lugs of the false-part easily, but without shake. Prepared facing-sand is next sieved over the pattern in sufficient quantity to cover it completely; the box is filled with old sand from the floor of the shop, and is carefully rammed up and stricken off.

After provision is made for the escape of gasses from the sand by piercing it all over with a sharp-pointed steel wire, known as a vent-wire, the two flasks are held together and turned over on a bed prepared for the drag upon the floor, or on a flat board if the boxes are small, and the false-part, hav-

ing done its work, is lifted off and emptied. An exact parting is now made with the trowel along the medial line, if the casting be symmetrical, the damp facing-sand being added or cut away sharply up to the pattern, as occasion may require. The parting-line is, as a general rule, that line upon the pattern, as it lies in the sand, above and below which the sides of the pattern slant inwards from the perpendicular. This is frequently an undulating line, but the parting surface always runs from it in all directions to the horizontal edge of the box.

Fig. 1. SLEEKER.

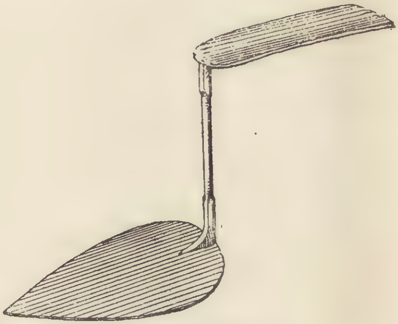
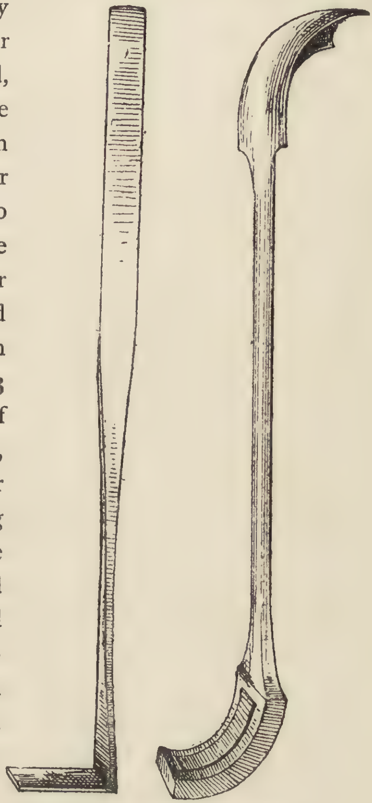


Fig. 2. SLEEKER.

Parting-sand is now strewn over the whole, and the surplus blown off. The upper flask or cope being replaced, a short cylindrical runner-stick is thrust into the sand of the lower part at a convenient distance from the pattern ; facing-sand is sieved on, the box filled up with old sand, rammed up, and stricken off as before. The vent-wire is then used as with the drag, the runner-stick withdrawn, and the opening left, through which the metal has ultimately to pass to the mould, is shaped bell-mouthed.

The moulder, either alone if the box be small, or with the help of other workmen or the crane itself if it be large, lifts the cope steadily upward, leaving the pattern in the sand of the

drag. The cope is then usually turned over on wooden blocks for repairing and dressing. The pattern has now to be drawn from the sand. This is done with the help of spikes, or screwed rods, temporarily attached to it; with one or more of these it is lifted, being made to vibrate the while by rapid rapping with a piece of wood or iron, for the purpose of causing it to leave the sand readily. The moulder has now to repair with suitable tools called sleekers, some types of which are shown at Figs. 1, 2, 3 and 4, any broken parts of the sand forming the mould, then to cut the runners or channels, from the opening left by the gate-stick to the mould, along which the fluid metal finds its way; and lastly to dust over the facing-sand surface of the mould finely powdered charcoal from a linen bag if for iron, and meal-dust, or some similar substance, if for brass.



Figs. 3 and 4. SLEEKERS.

Charcoal, when this is used, is sleeked down with trowels and sleekers as far as possible, so as to bring it into intimate contact with the damp sand. The excess of dust in every case is blown off with bellows. When the top part is closed, it occupies exactly the position it did before; the space then filled by

the pattern being now vacant and in connection with the gate, the fluid metal can therefore make its way in so as to fill such space, the form of which it will be found to have taken when cold.

The foregoing may be regarded as typical of all solid work in green-sand, the imaginary case described being almost the simplest possible. When hollow work is required, especially if the cavities are long or tortuous, dry-sand or loam cores are employed to form such openings. These are made either by pressing damp sand of suitable composition into a wooden sort of mould, known as a core-box, from which it is removed and dried by artificial heat, or by attaining the same end by the use of plastic loam on a perforated barrel or a core-plate. When such a core is perfectly dry, having received a thin coat of a mixture of clay, water and charcoal-dust, called black-wash, it is placed in position in the mould. This is determined, and the core is held in its place, by making it longer than the hole in the casting, and letting the extra parts rest in suitable cavities in the sand, made by projections on the pattern known as prints. An ordinary water-pipe is a good illustration of this class of work. The pattern for such a casting is solid, and has at its ends cylindrical projections of the inside diameter of the pipe. The long core, through which runs a perforated barrel for the escape of gas, rests upon that part of the mould which is made by the prints, and completely fills those cavities; but it leaves a space all round which exactly represents the pipe, and which is finally filled by melted metal.

Machine moulding is now largely used when large numbers of castings are wanted from one pattern. Figs. 5 and 6 illustrate two small moulding machines and their construction may be seen by careful inspection.

The machine shown at Fig. 5 consists of a bed-plate on

which rest two vertical columns, the distance between these is capable of adjustment according to the size of the pattern plate. In the columns are two spindles which carry the pattern plate in bearings; these spindles are telescoped up and down the columns by means of a hand lever; the pattern

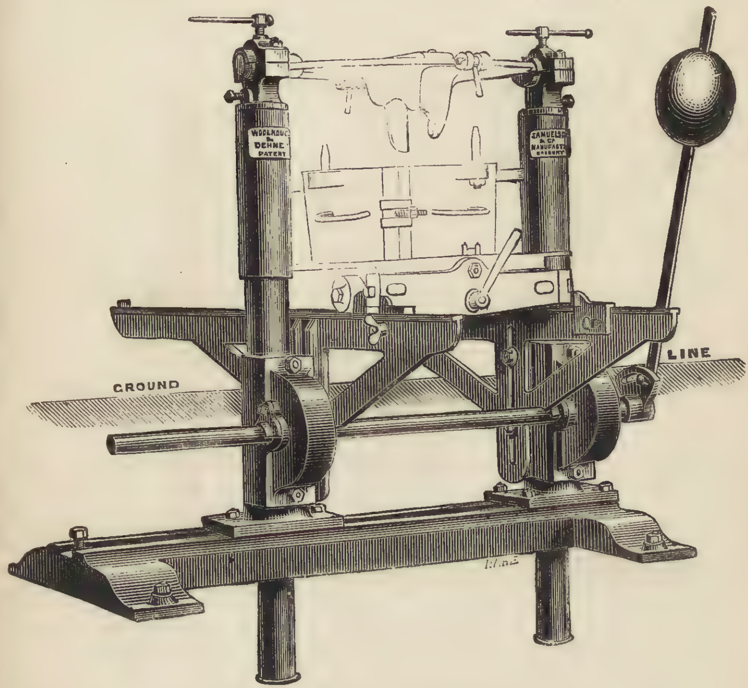


Fig. 5. MOULDING MACHINE.

plate can be turned completely round in its bearings. Underneath is a table running on rollers. The moulding boxes can be firmly attached to the pattern plate by means of split keys or screws. The bottom box is first fixed to the plate and the sand rammed up; the whole is then turned completely over and the box lowered until it rests upon the table; the plate

is then unfastened from the box and fixed in its bearings by the set screws and, by means of the hand lever, raised from the mould, giving it, at the same time, one or two gentle raps as it leaves the sand; the bottom box is now ready. The process of moulding the top is exactly the same as for the bottom, taking the impression from the other side of the

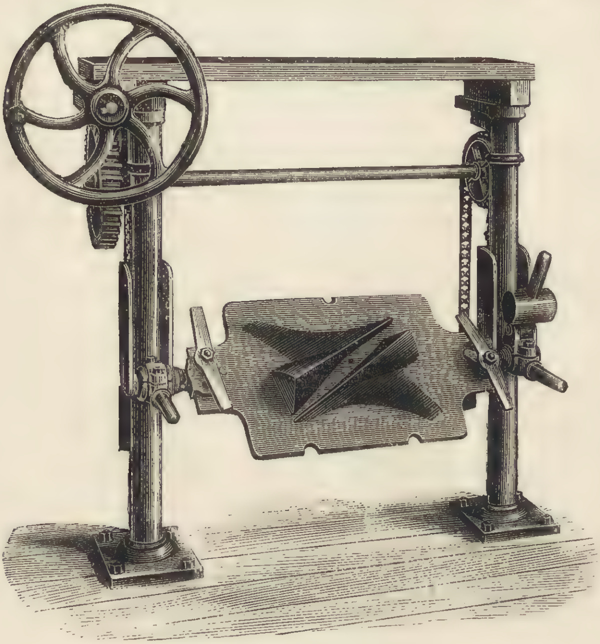


Fig. 6. MOULDING MACHINE.

plate. An accurate perpendicular lift and raising the pattern plates equally on both spindles prevents the breaking of the corners or the cracking of the sand, thus completely avoiding troublesome applications of water and the mending up of the mould. The advantages of machine over hand moulding, are, perfect lift, rapidity of work, and a labourer can work the machine, as beyond ramming up the sand no skill is required.

Dry-sand moulding may be regarded as identical in all essential points with that in green-sand, except that the mould when finished is thoroughly dried by artificial heat. By this treatment the sand, especially prepared for the work, is baked to a hard, compact mass. Dry-sand moulding is chiefly used for heavy castings, where great solidity and strength are required. The drying is done in a heated room called the stove or oven.

Loam, as prepared for loam moulding, is essentially to be regarded as a mixture of sand and clay, the latter in quantity sufficient to give a plastic character to the whole when tempered with water to the consistence of mortar or plaster. This material is much used for the construction of large moulds and cores, and, as has been previously stated, it obviates the necessity for patterns—generally very costly ones—and core-boxes. Loam cores are struck up, usually upon a hollow perforated spindle covered with a layer of hay-band. The spindle—often consisting of common gas-pipe—is made to run in notched trestles, upon which a loam-board rests parallel to the axis of the spindle. The loam is heaped upon this board, while at a proper distance the spindle is made to revolve slowly before it by a simple winch-handle. After it is thoroughly dried in the drying-stove, it is turned to the exact size, black-washed, and re-dried, when it is ready for use.

Loam-moulding is a process entirely distinct from either green-sand or dry-sand moulding. It is chiefly applied to large castings, such as cylinders, pans, or large water-pipes, and is really conducted on principles quite analogous to the above. As a typical instance, take the moulding of a large sugar or soap boiler's pan here described. Such a vessel is cast mouth downward. A heavy, flat, cast-iron loam-plate, in the form of a ring, is laid upon a low carriage or truck which runs in and out of the drying-stove. The outside and inside

diameters of this flat ring are respectively greater and less than that of the rim of the pan, and it is also provided with strong projecting staples by which to move it and the mould upon it, by means of the crane, from the stove-truck to the pit in the floor where the casting is made. In the centre of this ring rises a perpendicular spindle running in a long bearing provided for it in the carriage, and carrying a movable arm from its upper end. A templet of wood of the exact sweep of the inside of the pan is now clamped to the cross-arm of the spindle, and the latter is lowered so as to bring one end of the templet down to the plate, and there it is fixed. In revolving through a complete circle, the edge of the templet will now describe a figure representing the inside surface of the pan. A rough dome of common brickwork set in loam is built upon the ring, keeping it two or three inches clear of the templet, and leaving an opening at top large enough for the spindle to turn freely. Loam is then applied to the dome in two or three coats, and it is finally struck-up, with the help of the revolving templet, to an exact form. This structure is dried and then black-washed, and is known in loam-moulding as the nowel. The templet used hitherto is now replaced by another which gives the form of the outside of the pan. With its help the thickness is struck-up upon the nowel in loam which contains a good proportion of clay. It will be seen that this application represents the thickness of metal required for the pan. When dry, it is likewise black-washed, and re-dried; the last application in both cases being made to secure a parting. A second cast-iron ring, also provided with strong ears or lugs, is lowered down till it rests upon that part of the first loam-plate which extends beyond the thickness, last applied. A coating of wet loam is then put on with the hand to the surface of the thickness, and a second dome of brickwork is built against it. When all is dry, the position of the second ring is marked, if

not secured with pins. The crane is then made fast to it, and the cope is lifted off.

In all probability in doing this the thickness-loam will break to pieces; if it does not, it is gently knocked away, and the surfaces of both the nowel and the cope are repaired and dressed, and finally black-washed. Before this is done the spindle is lifted out, and the opening in the nowel carefully closed; that in the cope usually plays the part of ingate. When both parts of the mould are united, a space is left between corresponding to the thickness removed, ready to receive metal. By means of the crane, made fast to the lower ring, the whole is deposited in a pit, and old sand rammed around it, so as to hold the cope down, and increase its power of resisting the lateral pressure of the metal, which is very great. Adequate provision is also made for the easy escape to the surface of the gases generated by the hot metal, especially those forced inwards through the dried loam and brickwork of the nowel. The formation of the ingate is also carefully attended to.

In smaller foundries often, and sometimes in those which are very large, loam-moulds are made that cannot be moved, so rendering it necessary to dry them where made. In such cases slow-burning fires are made under them in the open shop, and the evaporation of the moisture is thus accomplished.

With some large cylinders, such as those of the Cornish pumping-engines, eighty to one hundred inches bore and twelve to fourteen long, also with the cylinders of the large blowing-engines and blast furnaces, the nowel and cope are made separately. The cope is built up and turned inside with a radius-bar; the core is erected on a plate on the floor and turned on the outside to a gauge; when dried, it is lowered into the cope by a crane.

A modification of the plan for loam-work casting of cylinders and similar large hollow articles is found in making the cope

devisible by a verticle joint, so as to separate laterally into two semi-cylindrical portions which rest upon semi-annular plates, so as to slip back when the thickness representing the metal is removed.

Large water-pipes are cast upon cores, which are made of a layer of loam upon a hay band wound upon a perforated pipe, the pipe being supported on bearings, and the loam turned off to a smooth surface, which is dried, and black-washed. The thickness is laid on and black-washed, and this substitute for a pattern is moulded in sand. The core with its envelope is withdrawn, and the thickness removed; the core is supported in the mould by the prints at the ends and by grains with long wires.

Pipes are also made from wooden patterns cut in halves through the axis. The drag and cope respectively receive the impression of one half, and when the pattern is removed the mould is ready for the core and the making of the ingate.

The moulds for crooked pipes and branches are frequently made in halves upon a flat iron plate. An iron bar or templet of the curve required is laid down, and a semi-circular piece of wood, called a strickle, is used for working and smoothing the half-core; next, a larger strickle is used for laying on the thickness; the two halves are then fixed together by wires, and are moulded in the sand-flask; the thickness is now slipped off the core, which is fixed in the mould by its prints, and, if needful, is supported also upon grains.

There are two general processes for casting gold, silver, alloys of copper, etc. The oldest in use from time immemorial in China, Japan and India, consists in forming the pattern of such a material that it can be burned or melted out of an otherwise solid mould, which is then filled with the metal. By this process, figures of most irregular shapes can be cast without difficulty. The patterns are usually made of wax, but they

may be made of any very combustible material, such as pine wood. Insects, small animals, fruits, leaves and other natural productions can be used as models, and placed direct in the mould.

There are many substances used to form the moulds; several kinds of clay, and also clay mixed with horse-dung; also river mud washed clean. A composition of one-third plaster of Paris and two-thirds brick dust, mixed with water, is perhaps as good as any. These moulds should be burned at a red heat, but not those made entirely of plaster of Paris. For smooth castings, the brick dust is separated into fine and coarse by throwing it into water. The coarser particles will fall to the bottom in a minute or two; the water is then poured into another vessel, and the rest of the brick dust will gradually settle down as a fine powder. This fine dust is mixed with fine plaster, and an even layer of it is carefully laid all over the model, which is then covered with the coarser mixture to a sufficient thickness. Small wires or cords should lead from the pattern to the outside of the mould, so that, on being drawn or burned out, they will leave apertures for the escape of the confined air from the mould when the metal is poured in.

The mould is dried gradually and heated until the wax runs out, or the combustible model is reduced to ashes, and is then baked in a stove or oven to a red heat. The runner or ingate for conveying the metal to the interior of the mould should be fixed to a part of the model and moulded with it. The runner may be shaped like a funnel, and should be of considerable size, that the weight of the extra metal may condense that in the mould, making a sharp and well-defined casting. Care must be taken to remove all the ashes of the model from the mould, which can be done by blowing through the holes made for the escape of air.

When the metal is poured in, the mould should be very hot. The Hindoos lute the mould to the mouth of the crucible, and heat the mould while the metal is melting; then, by simply reversing the crucible, the metal runs into the mould. This process is a very beautiful one, and work of the very highest art is done by it. The utmost care, however, must be exercised, as the pattern is necessarily destroyed, and, if the casting is a failure, there is no chance for another trial.

Soft and perishable objects may be also moulded so as to produce a single casting by one of the following methods, which are adapted to procuring castings of small animals, insects, flowers, feathers, ferns, seaweed, wax models, etc :—

Support the object in the centre of a small box by means of needles, one or two of which should be sufficiently large to form ingates. Some fine river-mud is dropped into the box and shaken around so as to adhere to the object. When partially dry, a coarser grade of silt is thrown in, and successively coarse qualities until the box is filled. The needles and ingate wires are now withdrawn, the mould burnt to reduce the object to ashes, which are shaken and blown out when the mould is ready for pouring the metal.

Another method is to take the object itself or a wax model, such as that of a flower, and suspend it in a box while plaster of Paris is carefully poured around it. The application of heat causes the object to burn or the plaster to absorb the wax; or, if the latter be in excess, it can be poured out. The strings by which the object was suspended are withdrawn, and the mould is ready for casting. The castings may be covered with gold or silver by the electrotype process.

The infinite variety of forms which the moulder is called upon to reproduce, as well as the constantly varying conditions and materials with which he has to deal, require much judgment, experience and forethought. For these reasons, also,

it is not possible to explain or even enumerate in the space at disposal the endless modifications which are constantly occurring in the above typical cases. A glossary of terms used in moulding, with explanations designed to elucidate this important, interesting and many-sided art, is given at the end of this handybook.

CHAPTER III.

BENCHES AND APPLIANCES.

THE use of makeshift tools and appliances will always be a source of monetary loss and inconvenience. Tools specially adapted for certain purposes will not only produce better work, but will do it in less time and at less expenditure of power and skill, so that the advantages of using the most appropriate machinery for doing certain work is obvious. It is by no means advisable to use tools of a superior class to produce work of a kind that can be made equally well with less expensive machinery, any more than it is commendable to use costly exotic wood to make a fire with when cheap waste is at hand.

The pattern-maker requires a bench of some kind, and in travelling from shop to shop in different countries, all sorts and conditions of benches are met with, and at which the pattern-maker is expected to feel at home. In some shops the benches are made with a wide board on edge in front, to support the top, leaving a space of about 18 inches between the floor and the under edge of this board. A good deal can be stowed away underneath this kind of bench, and one never knows the treasures they cover out of sight, to be turned out by posterity, or perhaps to remain for all time.

The same sort of bench, if made a foot or so wider, may have two men working at diagonal corners, and it becomes social. Rare old yarns are told across these big benches. On a double bench one's tools, especially when nice and sharp,

have a knack of travelling to the other corner, and the other man's idea of the extent of his half of the top may sometimes include about seven-eighths of its superficies.

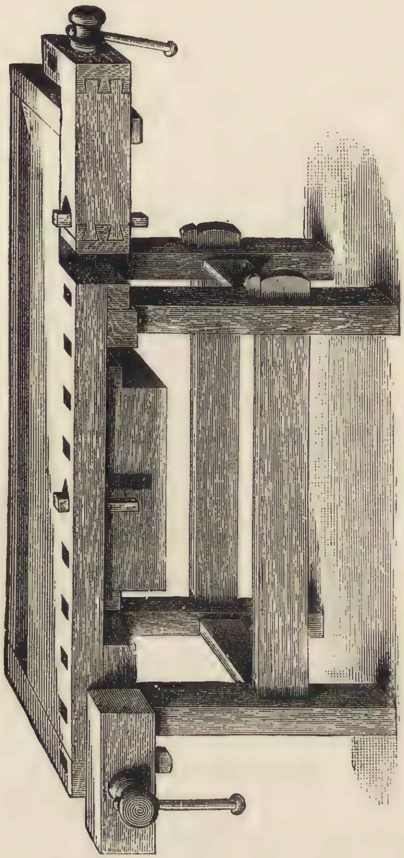


Fig. 7. German Bench.

Fig. 7 shows a bench now often met with, and one which is particularly useful for the work of pattern-making.

The bench next described is one suited to the small work-

shop. Fig. 8 is a sketch of it. The top is six feet long and two feet broad. It is in two pieces. The front portion is fifteen inches broad and two-and-a-half inches thick, of red or yellow pine, free from shakes and twisted growth; the back piece is nine inches broad and one-and-a-half inches thick, both rest on level rails, which make the back pieces one inch lower than the front. Along the back edge is screwed a rail of wood, which projects upwards one inch, and is therefore

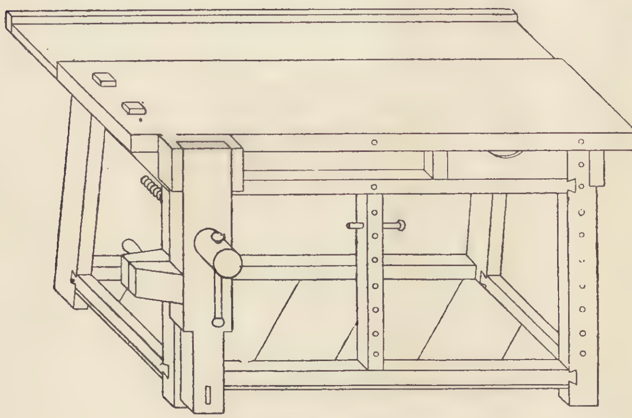


Fig. 8. BENCH.

on a level with the front plank, so that broad work will lie solidly across the bench. The object of having the back portion of this bench an inch lower than the front is so that nails and small tools or chips may lie in it without interfering with work on the bench. It also prevents the tools rolling off the bench, which they often do and are lost amongst the shavings.

The supporting frame of this bench consists of two rails screwed to the legs, as in the sketch. These rails are five inches deep and two inches thick. Three of the legs are four inches by two inches, and the fourth, that behind the "lug,"

is six inches by two inches, all of good red pine. The back legs slant inwards towards the top, the ends of the rails being rounded off. The lower rails, four inches from the floor, are three inches by two inches. The other three rails are of a length to make the frame measure five feet. Two of the rails are three inches from the floor, back and front, and one in front, four inches below the top. They are dovetailed into the legs, and fastened with large screws, so that the bench may be taken to pieces for removal. Under the lower rails a boarding is nailed for holding planes, mallets, hammers, &c., and a small drawer is often put in, as shown in the sketch.

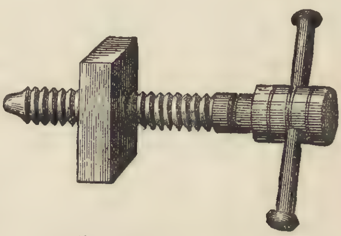


Fig. 9. Bench Screw.

The stops are put in this bench; they come through outside of the front rail. The screw, shown at Fig. 9, is the same as before described, but of larger dimensions; and, in addition to it, there is a side screw, which is found of advantage. The lug of this bench should be of clean, straight hard wood, seven inches broad, cut away at the bottom to four inches, and two inches thick. The sword is two-and-a-half inches broad and five-eighths of an inch thick. Sometimes the lug has a piece of hardwood screwed across its inner face at the upper end; this piece should be ten inches long, six inches broad, and one and a-quarter inches thick. For some purposes this is an advantage. The bench here shown is so fitted.

A piece of wood is mortised into the edge of the "lug," and a similar piece into the edge of the leg—they project outwards six inches. A short wood screw works through the back-piece, and its point presses against the piece projecting from the lug. The ordinary lug cants over when the end of a broad

board is caught in it, and the pressure is all on the edge of the board, which is very damaging to a piece of finished work. This side screw cures this evil, as it is turned out or in to suit the thickness of the work in the lug, the sword at the bottom being regulated by a pin.

In the front of this bench is an upright post between the two rails. It has holes for a pin, as has also the right leg. A hole is bored through the post at right angles to the others, and in this the pin is kept when not in use.

For general purposes, as good a stop as one needs is simply a square piece of hard wood, fitting tightly in a mortise in the bench top. It is suitable for the kind of bench shown in Fig. 8; but for a bench that has a front board about twelve inches deep some modification is necessary to save going down on one's knees to knock it up.

For general service a wooden stop is the best. It does not cut into or damage the work so much as an iron one. If a plane or other tool comes in contact with a wooden stop it will not destroy the edge of that tool; nevertheless, it is well to have an iron stop let into the bench. When not in use it sinks to the level of the top of the bench, so that it may be quite out of the way of the tools.

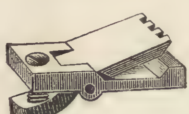


Fig. 10.
IRON BENCH STOP.

The special advantages possessed by an iron stop over one of wood are: The teeth of the iron stop, entering the wood, resist this tendency to slip to a much greater extent. And in planing thin stuff the iron stop is the best, because the wooden stop, when worn, or when the stuff is not lying perfectly straight upon the bench, allows the thin board to raise and pass over it when the force of the plane is applied.

The holdfast, or valet, is made of iron, and is used to hold work firmly on the bench to be mortised, or otherwise operated

upon. It consists of a round rod one-and-a-quarter inch thick, with a curved forked piece. In this fork is a lever-arm, fixed between the jaws with a pin. The back end of the lever has a square-threaded screw passing through, with its end coming in contact with the heel or end of the long bar. In using the holdfast, the bar is dropped through a hole in the bench top, the curved end of the lever coming down upon the work to be held. The pressure is applied by turning the the screw at back end of this lever, and by these means the work is securely held.

Fig. 11 is a handy vice, made to be held in the bench lug. It is very useful for holding small work to be sawn with the bow-saw, as this tool can be got round such work much better than when it is fixed in the lug itself; the operator can also stand erect. It is also useful for holding all kinds of small work to be operated upon with the chisel, file, spokeshave, or other tools, as well as for holding the smaller saws to be sharpened. It consists of two sides, or jaws, thirteen inches long, five inches broad at the upper part, three inches at the lower, and one-and-a-half inch thick, of beech or black birch. Through these jaws, five inches from the top, passes a wooden screw one-and-a-half inch diameter, and nine inches long on the screwed part. It goes freely through the front jaw, but is tapped into the other. Near the bottom is a five-eighths of an inch screw, tapped in the front jaw, and pressing against the other; its use is to keep the jaws parallel, as the sword does

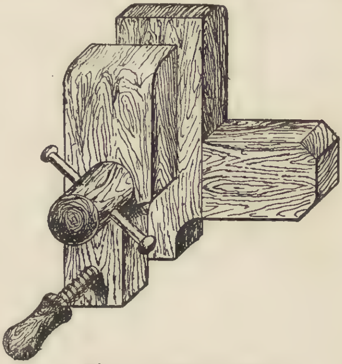


Fig. 11. Bench Vice.

the bench lug. Projecting from the edge of the back jaw is a piece, six inches long and four inches broad; by this the the vice is held in the bench lug. A small fillet is screwed to the back of the back jaw, which, resting upon the bench, prevents the vice slipping downwards when using it. The screw-head, three inches in diameter, and about the same length, has a wooden lever pin, nine inches long and three-quarters of an inch in diameter, passing through it; this should be of ash or rose-wood.

A hand-screw is shown, Fig. 12. It consists of two jaws and two screws. There are several sizes, and in a well-appointed shop generally about a dozen of each size. The large size has jaws about twenty inches long, three inches broad and two-and-a-half inches thick, with one-and-a-quarter inch screws about the same length. The second size has jaws fourteen inches long, and screws in proportion. The third size has jaws twelve inches long, two inches broad, and one-and-a-half inch thick. The screws are three-quarters of an inch in diameter, and have the screwed part nine inches long. The small size has jaws seven-and-a-half inches long, one five-eighths of an inch broad, and one inch thick. The screws are half-an-inch in diameter, and have eight inches screwed.

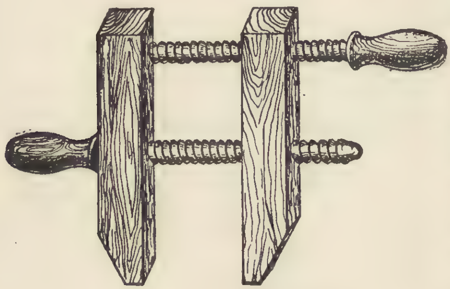


Fig. 12. HAND SCREWS.

In making hand-screws the two jaws are planed parallel, and tapered off at the end on the outside. In the middle of the length of the jaw a hole is bored to allow the screw to pass

through freely. In the other jaw, a hole is made and tapped for the screw, and at the end a second hole is tapped for the second screw. In the first jaw, and opposite the point of the back pin, a shallow hollow is made. This is simply to prevent the point of the screw slipping when the hand-screw is being fixed upon the work. To open these screws speedily to the required width, take the head of the middle pin in your left hand, and the head of the other in your right, and by twirling them one way the jaws are opened, and by twirling them the other way they are as rapidly closed. The screws should be blackleaded, and they then work easily in the threads.

Among indispensable tools is the cramp, made wholly of iron. A useful cramp is one that will take in three feet. This should have a lengthening bar, which will enable it to take in another three feet. The lengthening bar is attached with two short bolts and nuts. With this cramp, and a pair to take in thirty inches, and another pair to take in twenty inches, the workshop might be considered furnished with cramps.

The shooting and mitre board is shown at fig. 13. This board

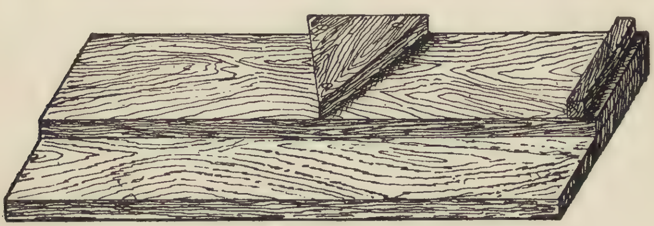


Fig. 13. Shooting and Mitre Board.

lies upon the bench and against the stop. Its use is for squaring the ends of short pieces of stuff, the plane being laid upon its side and pushed forward, and as a mitre board the plane is pushed in the same way, only the wood in this case is planed to an angle of 45°. This board is made of two pieces of Bay mahogany, each thirty inches long, six inches broad and one

inch thick. One overlaps the other two inches, and they are screwed together, thus forming a lower bed, four inches broad, where the plane runs, and an upper bed six inches broad. The under-side of the board must be made up at the ends by two fillets four inches long, two inches broad and one inch thick, screwed on, which gives a level bearing surface ten inches broad. A fillet, or stop, of mahogany is made, and sunk into a shallow groove an inch from the fore end, and at exactly right angles with the edge or shooting direction of the plane. A triangular piece is made, having two adjacent edges at right angles, and it must be placed upon the board about the middle of the length, with the right-angle corner pointing towards the sole of the plane, and the two edges exactly at an angle of 45° with the sole of the plane. It should be sunk into the board for about one-eighth inch, and fixed with screws. It has occasionally to be taken off, to admit of using the whole length of the board as a shooting board.

This board is used for mitreing all mouldings of a thin flat description. It is also used for small frame mouldings of all kinds. The use of a shooting board for jointing the ends is a common practice, but the joint is made more quickly and is stronger when made with a saw, which does not close the pores of the wood as a plane does when cutting at an angle with the grain; and the short grain on the corners is not so liable to break.

An American mitre planer, imported by Messrs. Churchill, is shown at fig. 14. It is made entirely of iron, and will plane any desired angle on straight or curved work. The bed piece is semicircular, with guides in which the plane runs. The movable quadrant has its sides at right angles; these act as guides for the material to be planed; it rotates on the stud A, and can be placed at any angle. When in the centre, a mitre joint is planed. The adjustable guides, which are fixed by the

screws D D, are used when pieces of oval or circular form are to be planed accurately to gauge.

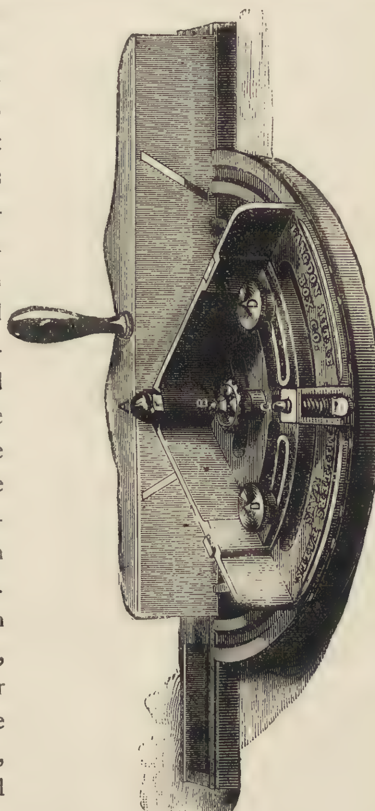


Fig. 14. Adjustible Mitre Planer.

Glue is used by pattern makers for joining the work. The surfaces of the wood to be united should be clean, dry and true; they should be brought together as tightly as possible, so that the superfluous glue is squeezed out. The cohesion of a piece of solid glue is found to be such that if two pieces of board had been well glued together the wood would yield in its substance before the glue. The strength of common glue for coarse work is increased by the addition of a little powdered chalk.

Glue is prepared from waste pieces of skin, horns, hoofs and other animal offal. These are steeped, washed, boiled, strained, melted, re-boiled and cast into cakes, which are then dried. The strongest kind of glue is made from the hides of oxen; that from the bones and sinews is weaker. Good glue should be hard in the cake, of a dark colour, almost transparent, free from black or cloudy spots, and with ittle or no smell. The best sorts are transparent, and of a

clear amber colour. Inferior kinds are sometimes contaminated with the lime used for removing the hair from the skins of which they are made. The best glue swells considerably (the more the better) when immersed in cold water, but does not dissolve, and returns to its former size when dry. Inferior glue, made from bones, will, however, dissolve almost entirely in cold water.

In using glue, break it into small pieces, cover it with cold water, and let it stand for from twelve to twenty-four hours, so that, as already mentioned, it swells to many times its original bulk. The soaked pieces are melted, without more water, over a slow fire and kept simmering for about a quarter of an hour, with frequent stirring. When cooled it is a firm jelly, of such a consistence as very readily to be cut by any instrument, but too stiff to be tremulous. When wanted to be used, it is merely warmed, which renders it sufficiently fluid to be spread over the surface of the wood with a stiff brush. Wood joined by glue requires from one to three days to be perfectly cemented, which is known by the hardness of the portion that remains on the outside of the joining, and the force of cohesion of the best glue is such that boards such as commonly used will quite as readily give way to violence at any other part of the substance as at the joining. Glue will not set in a freezing temperature, the stiffening being prevented by great cold.

The hotter the glue is when applied, the greater will be its binding power in holding surfaces together; therefore, in all large and long joints glue should be applied as soon as possible after boiling.

When glue is constantly required special appliances are used to keep a supply in readiness, and Fig. 15 shows Richards' Improved Steam Glue Oven which is made with double plates throughout, so that the pots do not come in contact with the steam or water. The steam chamber is cast in one piece, and

there is a joint where the flange is bolted on at the bottom. Steam and waste pipes, with screw valves, are fitted on each side, as shown. In front is a pet cock, for drawing off the hot water for mixing with the glue. There are three pots of iron, galvanised, which are turned at the flanges, so as to make a tight joint and prevent loss of heat. In the No. 1 size, the central pot, used for melting, holds one gallon, and those at the end one-third gallon each. A galvanised sheet-iron water

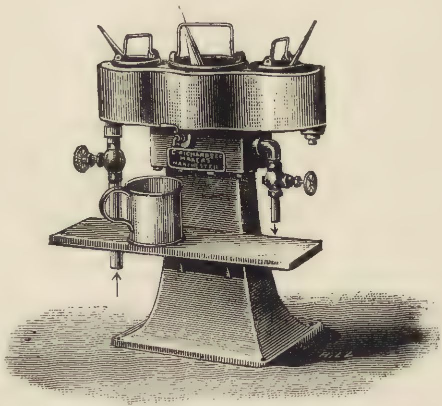


Fig. 15. Steam Glue Oven.

bucket, to hold one gallon, is also included with the ovens. In the No. 2 size all the pots are of the same size, holding each two gallons. The floor space occupied by the No. 1 size is three feet by two feet, and the No. 2 size three feet by three feet. There are a large number of these ovens in use, and they are strongly recommended by the makers for their cleanliness and safety from leakage.

Glue loses much of its strength by frequently re-melting, and that which is freshly made is preferable to that which is re-boiled. In melting ordinary glue in the double vessel con-

taining water, it is an excellent plan to add salt to the water in the outer vessel. It will not boil then until heated considerably above its ordinary boiling point; and the heat is retained longer. Glue may be freed from the foreign animal matter generally in it by softening it in cold water and washing it several times till it no longer gives out any colour, then bruising it with the hand, and placing it in a linen bag beneath the surface of a large quantity of water at 66° Fahr. The pure glue is retained in the bag, and the soluble impurities pass through. If the softened glue be heated to 122° and filtered, some other impurities will be retained by the filter, and a colourless solution of glue obtained.

As ordinary glue readily absorbs moisture, it is very liable to cause trouble if not protected from the damp moulding sand. Glue may be made waterproof by adding to it bichromate of potash, which should be previously dissolved in water.

CHAPTER IV.

HAND TOOLS.

SAWS are first in the lists of wood working tools, as with these, the first operation upon wood is performed. The ordinary wood worker has some six or eight saws, comprising the rip, cross-cut, panel, tenon, dovetail, bow and keyhole.

The first is used for cutting wood in the direction of the grain. The blade is twenty-eight inches long. It has three teeth to the inch, which are sharpened square across the blade, and are set very much forward.

The cross-cut saw is twenty-six inches long in the blade, and the teeth, four to the inch, are sharpened at an angle of about 60° with the blade. The teeth of these saws are set to clear the draught in sawing, for without set they would bind in the kerf. This set consists in every alternate tooth being bent outwards one way, the remaining teeth bent in an equal degree the other way. Every alternate notch is filed with the file pointing to the right, at an angle of 60° : and the intermediate notches are filed with the file pointing to the left at the corresponding angle. The outer corner of each tooth is thus brought up to an acute point ; and looking along a properly set cross-cut saw, an angular furrow is shown along the teeth.

The panel saw is the same length as the cross-cut, but has seven teeth to the inch. The teeth are sharpened at right angles with the blade like the rip saw, but are not so much set forward ; it is an excellent saw for either light ripping or

cross-cutting; and with this saw in his possession the pattern maker may dispense with the other two described above—they being used only for heavy sawing.

The tenon, or sash, saw, Fig. 16, has a thin blade, fourteen inches long, with a brass or iron back to stiffen it, and a closed

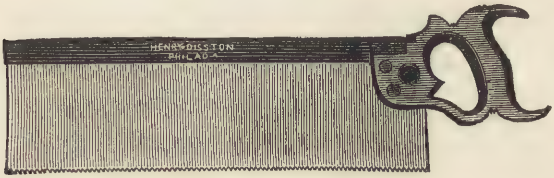


Fig. 16. Tenon Saw.

handle. It is used for every kind of sawing, whether with the grain or across, and particularly for ripping off the cheeks of tenons.

The dovetail saw, Fig. 17, is used for dovetailing, as its name implies, besides for an infinity of small work. It has a very thin blade, ten inches long, very fine teeth, a brass back, like the tenon saw, and an open handle.

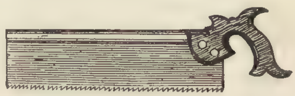


Fig. 17. Dovetail Saw.

The bow saw is a most useful tool for all kinds of small curved sawing. It consists of a frame made of beech or rosewood; the two ends are held apart by a stretcher let into them by a short tenon, near the middle of their length; through the lower ends, the handles are inserted, having short brass rods riveted through them; the inner ends of the rods are slit to receive the saw-blade. A strong cord is wound round the opposite ends of the frame, and by means of a short wooden lever the cord is tightened by twisting, which pulls apart the lower ends and tightens the saw-blade. Both handles carrying the blade, which is twelve inches long, turn

in the holes, and thus facilitate getting round curves. In using this saw the work is held in the "lug," and the saw is held by one handle, the forefinger passing round the front in front of the handle. The teeth of the saw are pointing from you; consequently, the sawing is done with the push forward, not with the pull back.

The keyhole saw consists of a handle about nine inches long, with a brass ferrule. It is pierced with a narrow slit from end to end, and the blade, which is very narrow at the point, and has five teeth to the inch, may be shortened or lengthened at pleasure by means of the hole in the handle, and fixed at any desired length by two binding-screws in the ferrule. This saw is handy where the bow saw cannot be used.

Planes are the tools chiefly used for smoothing the surface of wood after it has been sawn to approximate size. The stocks of planes are now made both in wood and in iron. Iron planes bear the same names, and are used for the same purposes as those made of wood, but they are more costly.

Some people prefer wood, but iron planes are rapidly making their way, as they deserve to, having several good points which the wooden planes have not. Unless a plane is straight we cannot expect to plane straight with it. A round plane planes hollow, and a hollow plane planes round. A wooden plane is constantly changing it shape, in a more or less perceptible degree, for reasons that are constantly operating, viz. : the wear of the work, and tension produced by the wedge, and the dry or moist state of the atmosphere. It is usual for a workman, who has some particularly accurate planing to do, to commence by first "truing" his plane. Every time the sole of a plane is dressed, the mouth becomes a little wider, and at last it gets so wide that shavings stick

in it, and trip the plane out of its cut. A plane with a wide mouth has a tendency to cut deeper than set for, when it approaches the end of the board. An iron plane practically does not wear at all. There is no wedge to spring it; it is not affected by the weather, and its mouth remains the same size.

In a wooden plane the cutter is fixed in its place by blows of the hammer on a wedge. It is loosened by blows upon the plane itself. No tool on the bench has a more worn and battered appearance than the plane. Blows of a hammer deliver a very uncertain pressure. A wooden plane might be true when three blows were struck on the wedge; a fourth blow might curve it. The knife in an iron plane is held down by an at all times equal pressure; the depth of cut can be regulated to a nicety and with the greatest ease.

Iron planes are a little heavier than wooden ones. An occasional touch of oil makes these iron planes glide like a skate over a piece of ice. Before the introduction of iron planes we had nothing to plane circular curves with. You could have a bow-plane to fit any circle, but it would fit only the curve it was made for. Now we have (Fig. 18), a plane with a spring steel sole, which may be adjusted to suit any circle down to thirteen inches diameter, internally or externally. It is the pioneer plane of its kind; there is nothing else like it.

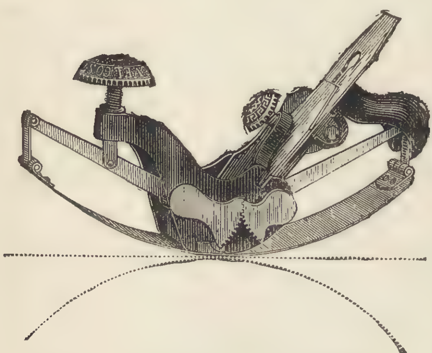


Fig. 18. Adjustable Circular Plane.

Iron planes have a decided advantage over wooden ones for many purposes. The iron half-long being planed accurately on the sole, makes the long joints with much greater facility, and does not get out of truth like the wooden one. The iron panel plane gets up a smooth surface on hard wood much better than the wooden one. The iron smoothing plane has a similar advantage over that of wood; and the iron rabbet plane may be said to be almost indispensable. These are made with the soles from half-an-inch to one inch wide, the sole and sides being iron filled in with wood. A useful size is five-eighths of an inch, which has two irons, one being near the front. It is used for cleaning out the square angular corners of mouldings, checks for panels, etc.

A great variety of iron planes are now imported from America. They are generally made of cast-iron. The home-made ones are malleable iron, often filled in with wood, giving them a more substantial appearance. American are largely used, being cheaper and generally lighter to handle. One, the American iron smoothing plane, has a handle similar to a half-long plane: behind this handle is an adjusting screw, by which the cutting iron can be moved backwards or forwards to a nicety, and the means used to fasten the iron is very simple and effective. The plane is light, and, having the handle, can be used with one hand. It is invaluable for smoothing cross-grained hard woods and many other purposes.

The usual bench planes comprise the jack plane, which is the first that is applied to the wood after being sawn; it is seventeen inches long, and has an iron or cutter two-and-one-eighth of an inch broad. Immediately behind the iron is a handle similar to that of a saw. In use it is grasped by the right hand only in planing fir, but in heavy planing, and especially hard wood, it is necessary to place the left hand across the front of the plane to press it down, as it is too light of itself for the

iron to take hold of the wood. When using both hands to the plane, the left is placed with the four fingers lying across the top near the fore end, the thumb passing down the near side. In order to remove the irons for sharpening, the plane is tapped on the upper side, near the fore end, with a hammer.

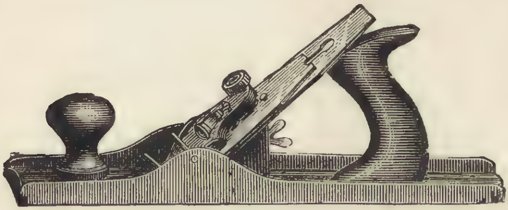


Fig. 19. STEEL JACK PLANE.

Two taps should loosen the wedge and the irons. In setting up after sharpening, the back end of the cutting iron is tapped to give more iron; and to give less iron the fore end of the plane stock is tapped gently. To set the iron evenly with the mouth, it is tapped on the edge behind the wedge. During this process of setting the iron, the eye is travelling along the sole of the plane, the end resting on the bench. A little practice enables the operator to set his iron very quickly.

Fig. 20. WOODEN HALF-LONG PLANE.

The half long plane is from twenty-two inches to thirty inches long; the longer sizes being called jointers. Twenty-four inches is the most suitable length for ordinary purposes.

It has an iron like the jack, two-and-a-half inches broad, and a slightly different handle. This plane is used for dressing the wood after the jack, as it takes off the ridges left by that plane, and produces a more even surface. It is also used for squaring up and bringing the pieces to the desired measurements previous to framing them together—and from its great length is well adapted for making long pieces practically straight on the edges—and for joining two or more pieces together to form a broad piece, it is indispensable.

The smoothing plane, for fine or other soft woods, is nine inches long, having an iron two-and-a-quarter inches wide on the cutting face. The cutting iron has the same pitch, or angle with the sole, as the half-long. The stock of this plane has the sole and top parallel, but the sides are curved, making the two ends narrower than the centre.

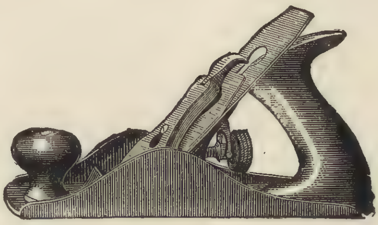


Fig. 21. Iron Smoothing Plane.

The irons are held in place by a wedge, but this plane has no handle, and when using it, is held by both hands, the right behind, and the left before, unless occasionally when it is necessary to hold or steady the work with the left hand, then the right grasps the back part of the plane. This plane is used to put the finishing surface on the work in hand. After the drawing in, mortising, tenoning, dove-tailing, etc., have been done, and before a job is put together, all the parts that cannot afterwards be operated upon, are finished with this plane.

The smoothing plane for hard woods is in shape the same as the above, but only seven-and-a-half inches or eight inches long, with a two-inch iron is set at a higher pitch—that is, it

does not slant back so much. This plane is used for the same purpose in the finishing of hard woods as the other is for pine.

The toothed plane has a stock similar to the hard wood hand plane, but the iron, instead of having a cutting edge, presents a series of sharp teeth to the wood. This serrated edge is formed by long narrow groves on the face of the iron next the wedge, and when the iron is ground in the usual manner these ridges terminate in sharp points. In setting-up this iron on the oil-stone only the ground back is applied to the stone. The position of this iron in the stock is nearly perpendicular, so that it is simply a scratch plane, and to do this it needs no cover like the others. Its use is to roughen the surfaces of pieces to be glued together, for while it takes off the ridges left by the half-long or panel plane, it roughens the surface by scratching, thereby adapting it better to hold the glue.

The core-box plane is specially a pattern maker's plane generally known by the above name, but as core-boxes are of all shapes, it would seem that "half-circle plane" would be a more fitting name for it. Its action depends upon the fact, as demonstrated in Euclid (Book III., prop. 31), that "the angle in a semi-circle is a right angle."

If two pins be stuck in the bench and a square be held against the pins, and moved so that the blade and back of the square slide against the pins, then the apex of the square wi l describe a perfect half-circle.

The core box plane, a top view of which appears in Fig. 22, and an end view in Fig. 23, is seldom to be met with in tool warehouses, so those pattern makers who require it generally make it for themselves. Fig. 22 shows, perhaps the readiest method of constructing one of these useful tools. A common round plane, No. 12 size, has its sole planed to a right angle,

having the apex of the angle in the centre of the plane. Take two pieces of beech, or other hard wood, ten inches long, and seven inches wide, glue them to the plane, level with the faces previously planed on its sole; strengthen by the addition of the four brackets shown at the corners. The mouth of the plane should be recessed to give free exit for shavings, so that the plane can be easily cleaned out if it chokes. A handle should be fitted, and, of course, the cutting iron will need to be ground to suit the new shape.

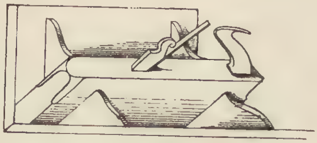


Fig. 22. Core Box Plane (Elevation).

Some take a rabbet-plane and fix one piece to it, so that the plane itself forms one side of the right angle. This is a simple method, but the shavings do not come out so well. Others make it out of a solid piece, or the middle piece is solid and the sides are added, as Fig. 22. Or the middle piece is made in halves, for convenience in cutting out the mouth. All these methods are good if properly carried out, except the one that employs the rabbet-plane. The manner of using the core-box plane is shown in Fig. 23. The dotted line is the half-circle to be worked out. Having roughly gouged out a portion of the material, make the checks *a* and *b* by using the straight-edge *c* as a guide. Now that the plane has a good start, remove the straight-edge and continue planing, using the gouge occasionally, as the margin of stuff becomes too wide for the width of the plane-iron. A taper half-round box may be planed out with this tool as easily as a

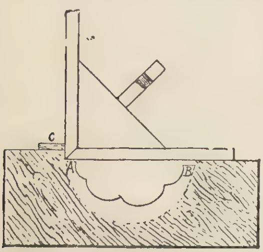


Fig. 23. Core Box Plane (End View).

half-cylinder, and, as the work is done on a correct principle, true cylindrical or conical surfaces are produced in the planed core boxes.

The Router, or old woman's tooth, is a simple plane to make. The stock is often made of a piece of hard wood

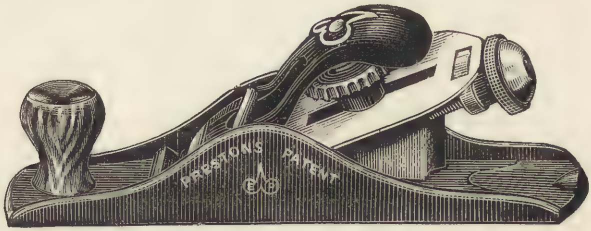


Fig. 24. IRON BLOCK PLANE.

about six inches by four inches by three inches. A taper mortise is cut through the thickness of the wood to accommodate a cutter half-an-inch wide with a wedge behind it. A piece is to be cut out of the middle of the sole in front of the iron, as an escapement for shavings. These are all the essentials, though a graceful shape is generally given to the stock by the maker. The use of this tool is to plane out grooves of any required depth, which is done by tapping down the iron at every fresh cut

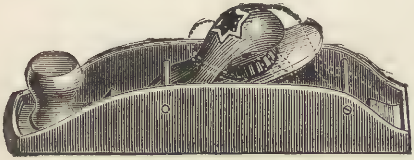


Fig. 25. COMBINED BULL NOSE & BLOCK PLANE.

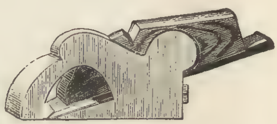


Fig. 26.
BULL NOSE PLANE.

until the full depth is reached. Cutters of differing shapes may be employed and guides may be screwed to the sole; with these, recesses may be worked out having a curved form at the bottom, and always in a certain position in any number

of pieces. It is slow in its action and liable to chatter when the iron extends far below the sole.

Fig. 25 shows an American plane having two distinct slots or cutter seats, so that the iron can be shifted to form either a Bull nose plane or a Block plane.

Fig. 27 shows another American plane arranged to cut chamfers to any ordinary width. The front part of the plane carries the cutter, it slides upon the back part, and can be champed where desired. With the front part brought down to be level with the back, this plane forms an ordinary bench plane.

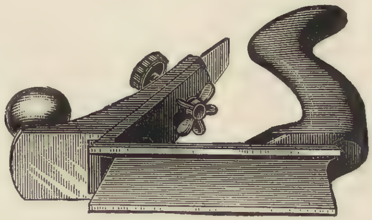


Fig. 27. Adjustable Chamfer Plane.

A mitre plane is the kind to use on the shooting board and mitre block. It has the iron two-and-a-half inches broad, it lies very flat down, and has the ground side uppermost; and the opening in the sole is a mere slit. This plane is the best for hard wood, but good work may be and is done with the half-long for the shooting board and the hand plane for the mitre block.

Apart from the common bench planes there are a host of others, and some of them cannot well be dispensed with in pattern making. Hollows and rounds are very useful, as with them mouldings, both internal and external, may be worked. They go in pairs, each round having its corresponding hollow; and there are sixteen pairs in a full set, from one-eighth-of-an inch to two inches. But eight pairs or a half set are generally used.

The plough has eight irons, ranging from one-eighth-of-an inch to five-eighths-of-an inch. It has a moving "fence," and

is used for all kinds of joining by feather and tongue, and with the groove running with the grain of the wood.

The rabbet plane, for hard wood, is seven-eighths-of-an inch broad, the cutting it makes being of the same breadth; the mouth runs square across the sole. That for soft wood is one-and-a-quarter inch broad, and has the mouth and cutter running obliquely across the sole, and the iron is not so high in "pitch" as for hard wood.

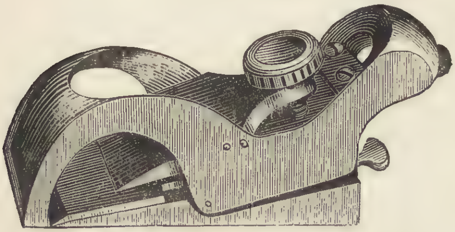


Fig. 28. Iron Bull Nose Rabbet Plane.

The fillister is a rabbet plane with a "fence" and a guide for working to a given depth and width.

Two or three pairs of match ploughs, from three-eighths-of-an inch upwards, are also useful.

The draw-knife is a tool almost equal to the axe for making chips, in shaping work. A draw-knife is shown in Fig 29. Both

Fig. 29. Draw-knife with Adjustable Handles.

its handles are adjustable. On the right hand is shown the method of attaching the handles. By slacking the nut the handles may be drawn back and adjusted to any angle. Teeth

in the handle engage with teeth on the shank of the knife, so that when the nut is again tightened the handle is fixed in its new position. This improved draw-knife can be got to work in places inaccessible with the ordinary tool.

The spokeshave, Fig. 30, has its blade in the centre, and a handle at each end, and is used for taking off shavings from narrow surfaces where perfect evenness is not essential. Iron planes suggest iron spokeshaves, which are far ahead of the old

Fig. 30. SPOKESHAVE.

wooden spokeshave, with its cutting tool like a square staple, the horns of which prevent its being ground upon a grindstone. We now have an iron spokeshave which can be sharpened as easily as a plane, and it is adjustable to suit different curvatures.

The square has the stock made of wood with a steel blade set at right angles, both handle and blade being straight edges. Besides these there are other squares—the twelve-inch steel-bladed and large wooden ones, up to three feet in length. The bevel is somewhat similar, but the blade is adjustable to any angle. The mitre bevel is made of wood, and resembles the square and the bevel; its blade is fixed at an angle of 45°. Usually blades are one-sixteenth of an inch thick, and the stock five-eighths of an inch, both being about two inches broad. This is useful for marking off at an angle of 45°, pieces of any sort to be mitred together.

There are three distinct gauges—the marking, the cutting, and the mortise gauge. Each has a shank about nine inches long, with a head or block to slide along it. The marking

gauge has a spike inserted near the end of the shank, and the moveable head is fixed by a screw or a wedge at any required distance from the spike. Its use is to make a mark on the wood, parallel to an edge previously straightened, and along which the head of the gauge is guided.

The cutting gauge has, instead of the spike, a thin steel blade passing through the shank, and fixed by a screw. This blade being sharpened makes a cut either with or across the grain. It is used for gauging all kinds of work, for cutting through thin wood to a given breadth, and many similar purposes.

The mortise gauge has two spikes, one fixed and the other moveable by means of a screw in the end of the shank. It is used for gauging all kinds of mortise and tenon work.

Other indispensable tools are :—two-foot rule, oilstone slips, oilcan, glue-pot mallets, hammers, nail punches, compasses rasps and floats, brace and bits, dowel-plate, scraper, screw-drivers, and sets of chisels, gouges, gimlets and bradawls.

Fig. 31 shows a bit particularly handy for boring holes of unusual diameter, it being adjustable to any size within the limits of its range. Two sizes are made, one boring from half-an-inch to one-and-a-half inch, the other from seven-eighths of an inch to three inches. It is an American tool.

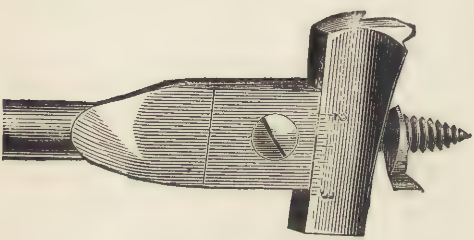


Fig. 31. Expansion Bit.

The American drill shown at Fig. 32 is particularly useful for boring holes through wood where several pieces join, as the drill will not run out of its true direction. The centre and the cutting lips can be renewed as they wear.

The dowel-plate is a steel plate about half-an-inch thick, with holes from three-sixteenths of an inch to half-an-inch, and the bits correspond so that dowel pins made in the holes will fit holes made by the corresponding bits. The scraper is a bit of steel plate about the thickness of a handsaw blade ; it is five inches by three inches. Its use is to take off any ridges left by the smoothing-plane in planing hard wood, produces a

Fig. 32. TWIST DRILL FOR BORING WOOD.

surface free from lumpiness, and is used before the glass paper. Glass-papering is done with the paper wrapped round a piece of cork. The usual size of which for large flat surfaces is five inches by four inches, and about one inch thick. One side is made quite flat, and on this the paper is placed. Pieces of cork are used for glass-papering all kinds of hollows, rounds, mouldings, etc., the cork being shaped with the rasp to fit the part to be papered.

CHAPTER V.

MACHINE TOOLS.

AN idea prevails that machinery is not well adapted for pattern making on account of the endless variety of work to be produced. This idea is, however, not founded on fact, and the judicious use of suitable machinery is distinctly advantageous, both in cost and in quality of the work produced. Few English firms have as yet made much progress in producing the machine-tools required for pattern making, and those shown in this chapter are mostly from one firm—Geo. Richards and Co., Limited.

Lathes are the machines claiming early consideration under this heading, but as the subject of wood turning forms the matter of another handybook in this series, the attention will be here confined to some lathes specially constructed for pattern makers.

In every pattern maker's shop there is a large amount of turning of hubs and bosses, and face plate work generally; in fact, sufficient to give almost constant work to a small handy lathe.

Let us pass lightly over the ordinary pattern-maker's lathe; it is a tool that, with slight exceptions, reached its maturity in the far past. There is very little that is new about it. Two ideas that have been very generally put into practice on this kind of lathe—one, the tripod tool-rest; and the other, cutting a left-hand screw on the tail-end of the mandrel. This saves the trouble of turning the headstock around on the bed when-

ever a job has to be turned which was too large to clear the bed of the lathe. The tripod, shown in Fig. 33, is a very useful contrivance. It stands, like a three-legged stool, upon the floor, is readily shifted, and, though light, is sufficiently steady.

Fig. 33 shows Richard's standard form of face plate lathe for general work, a small face plate lathe capable of taking the greater share of such work in ordinary pattern making. It is constructed entirely of iron, and is arranged for turning pieces up to four feet in diameter at the back end of the mandrel, and pieces twenty-four inches in diameter at the front end. The bearings are made of phosphor bronze, and the mandrel is of large diameter. A moveable centre is arranged on the front of the lathe for turning pieces up to fifteen inches long. The frame of the lathe is heavy enough to resist the vibration in turning large pieces, and is cast complete with the bearings carrying the spindle. The tool rests are constructed to be readily adjusted, rendering them very convenient for moving out of the way, or for measuring the inside of the work. Each lathe is supplied with two rest stands, two T rests, three face plates, three centres, a floor stand and countershaft. The countershaft has fast and loose pulleys, eight inches by two-and-a-quarter inches, and should make 600 revolutions per minute.

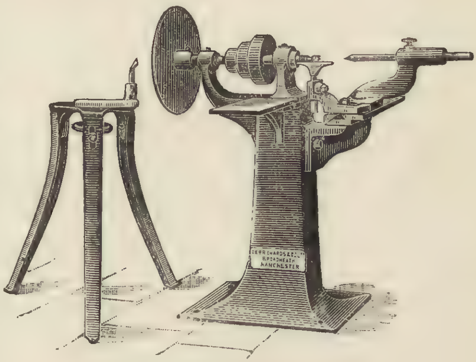


Fig. 33. FACE PLATE LATHE.

The weight of the machine is about eight hundredweight

complete. Floor space required about six feet by three feet, and power required one-and-a-half horse-power.

Fig. 34 shows Richards' standard form of lathes for pattern work, with frame of wood. They are made to various lengths, according to requirements, and are arranged for turning a large diameter over the left end of the lathe. For this reason, the bearings at both ends of the cone are the same size, of four diameters in length, composed of phosphor bronze, thus giving a large amount of surface to resist the vibration in turning heavy pieces of wood at high speed. The lathes are complete, with two rest stands, three T rests, three face plates, five centres, floor stand and counter-shaft, complete with fast and loose pulleys. They are admirably adapted for shipping abroad, where it is desired to save expense in carriage, as the wooden frame can be completed by the purchaser. They are made in the following sizes and lengths :—Six-inch centre, to turn a piece four feet long; eight-inch centre, to turn a piece five feet long; ten-inch centre, to turn a piece six feet long; twelve-inch centre, to turn a piece eight feet long.

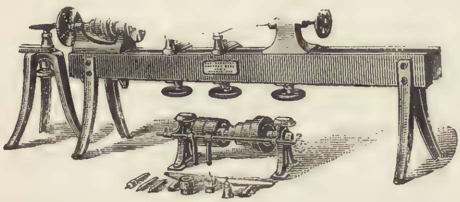


Fig. 34. STANDARD LATHES WITH WOOD FRAMES.

Fig. 35 shows Richards' standard form of wood lathe, containing a number of improvements in detail, which render it specially applicable for turning wood. It is constructed entirely of iron, and is specially arranged for turning large pieces at the back end of the mandrel, for which purpose the bearings are made of phosphor bronze, four diameters in length, thus giving a large amount of surface to resist the vibration in turning heavy pieces of wood at high speed. The frame of

the lathe is cast complete with the bearings carrying the mandrel, while under the headstock is placed a heavy hollow frame, for the purpose of resisting the vibration in turning large pieces. The tool rests for these lathes are constructed on a special plan, by which the tool rest and carriage are clamped with one bolt, rendering it very convenient for sliding them back for measuring inside work. In turning large pieces a face-plate is placed on the outer end, and the bracket which carries the thrust screw at the end of the spindle is removed. It should be noted that the engraving below shows the lathe arranged with self-acting feed motion. The carriage, which is moved automatically, is arranged with a flat top, to receive the standard rests, or, as shown in the engraving, with compound rests. The lathes are made in four sizes, and to turn lengths as shown below. They can, however, be made of special lengths to order. Each lathe is provided with two rest stands, three T rests, three face plates, five centres, a floor stand and countershaft.

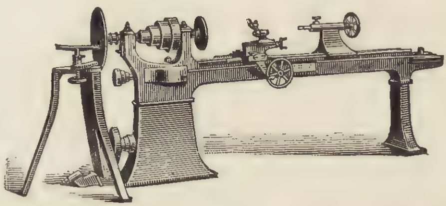


Fig. 35. Standard Lathe with Self-Acting Feed Motion.

	Centre.			Countershaft.	Driv. Pulleys.
No. 1,	6in.,	to turn a piece	4ft. long ;	600 revs. ;	8in. by $2\frac{1}{4}$in.
,, 2,	8in.,	,,	5 ,,	550 ,,	10in. ,, $2\frac{1}{2}$in.
,, 3,	10in.,	,,	6 ,,	500 ,,	10in. ,, 3in.
,, 4,	12in.,	,,	8 ,,	450 ,,	12in. ,, $3\frac{1}{2}$in.

As there is so much planing to be done in pattern making, provision should be made for performing such heavy work by machinery, especially as manufacturers have now placed on

the market small inexpensive machines, capable of doing some very heavy work.

Fig. 36, shows a safety hand feeding planing machine. This class of machine is of comparatively recent introduction in the trade, and has become extremely popular. They are used for planing the surfaces and edges of timber of any size, without alteration to the machine. The cutter head revolves below the tables, and the wood is held down and fed by the hands. All sizes of these machines are provided with means of protecting the workman's hands. The tables, both before and after the cutter, are adjustable vertically, to regulate the depth of cutting, while, by means of automatic stops, the tables cannot be brought in contact with the cutter block as their heights are altered. The machines are complete with cutters, adjustable bevel gauge, countershaft and wrenches. The special features claimed for the machine, shown at Fig. 36, are—Covering of the cutters by an adjustable safety guard without interfering with the efficiency of the machine. Making the cutter block and journals of forged steel, with solid lips supporting the cutting edge. Setting the cutters upon a new principle, at an angle with their axis. Each table rests on four links, moved by a screw and the handle seen at the end of the table, and arranged so that the workman cannot bring the table edges into the cutters. All the sliding joints are horizontal, and secure perfect allignment of the tables. The tables can readily be drawn back, to

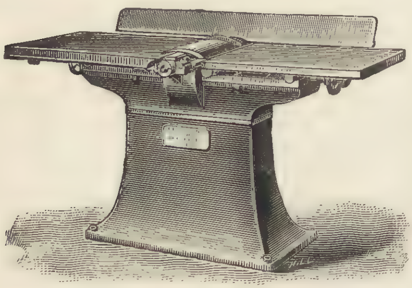


Fig. 36. Planing Machine.

get at the cutters. The ends of the tables at the cutters can be raised for planing hollow joints for glueing.

A special machine for pattern making is the Dimension sawing Machine, Fig. 37. These machines are made in two sizes and bear the same relation to wood cutting that a Shaping and Planing machine does to metal cutting. The surfaces produced are smooth, ready for glass-papering, and are also perfectly square and true, the applications of the machines are almost unlimited, as will be seen by numerous diagrams, which show a few of the many operations to which the machines can be applied, even by the unskilled. These machines are particularly applicable to pattern making, where almost every piece is worked to some dimension. It is claimed that when operated in conjunction with a Hand-feeding Planing Machine, Fig. 36, they will effectually dispense with one-fourth the labour of pattern making.

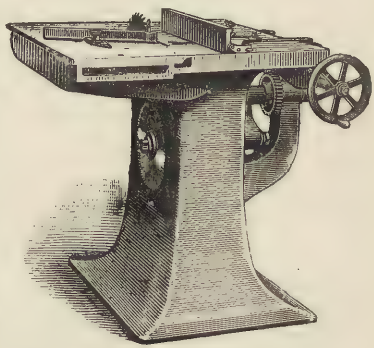


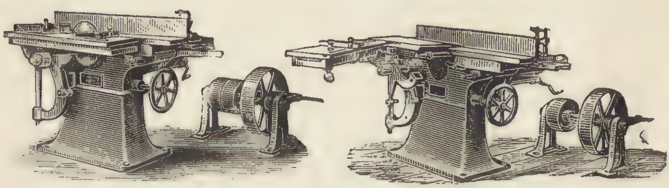
Fig. 37. DIMENSION SAWING MACHINE.

Two saws are used, twelve inches in diameter, one for slitting and cross-cutting. They are raised through the table to any desired height by the hand wheel seen at the right. By removing both saws, a single saw, eighteen inch diameter, can be used on this size of machine, for coarser classes of work occasionally required. The saws are made specially for these Machines; being some gauges thicker at the periphery, and are ground concave on both sides. They require very little "set," are very stiff, and produce a fine surface when at their lowest position. They are very accessible for changing.

The table consists of two parts, that on the right hand of the saw is fixed to the main frame, and has fitted in the top of it a very accurate adjustable gauge, moved approximately to any position by the hand, and then clamped to a slide, which is then moved by a screw for close and accurate setting. This gauge is readily removed for cross-cutting long pieces. The table on the left of the saw slides easily on carefully-fitted ways. It has an adjustable gauge, with an index to set at any angle.

The countershaft is placed below the floor, in a swinging frame to adjust vertically. Both the saw spindles are driven by one band, although both saws do not run continuously. The countershaft has fast and loose pulleys, ten inch diameter, for a four inch belt, and should be driven six hundred and fifty revolutions per minute. Diagrams are supplied showing the manner of erecting the machine and the special countershaft under the floor.

Variety Wood Working Machine. This is a complete machine for accomplishing nearly all the operations of planing



Figs. 38 and 39. VARIETY WOOD WORKING MACHINES.

and sawing for finishing work. Fig. 38 shows the machine complete with sliding-table in position, and Fig. 39 shows this table swung aside to disengage the end bearing of the spindle for changing cutters, &c. It is a combination of the principles embodied in Hand-Feeding Planing Machines, Fig. 36, and Dimension Sawing Machines, Fig. 37.

The simplicity of its construction enables it to be adapted, with very slight and rapid change, to the following numerous operations : — Planing out of wind, Planing straight or taper, tenoning, rebating, jointing, bevelling, graining and notching, squaring-up posts, cutting mouldings of any shape, slitting and cross-cutting, grooving, &c., boring, slot mortising, recessing, &c. On pages 67 to 69 are shown diagrams of work and description of how to operate the machine.

The spindle rises and falls below the table top, being rapidly adjusted by the hand-wheel shown. The back table is stationary, while the front one is adjusted similarly to the hand feed planing machine. The sliding-table on the left is similar to the loose table in the dimension sawing machine, and is fitted to accurate planed ways. The bracket on which the table slides is pivoted to swing out of the way, to get at the spindle end for changing the cutters or saws, or when the machine is being used for planing or other operation, as explained.

The following are supplied as part of the outfit of the machine :—A countershaft complete, one cutter head twelve inches long, fitted with two cutters ; one twelve inch circular saw, and a full set adjusting collars.

The following are supplied to order as required :—Boring stand complete, rebating head, tenoning head, grooving heads, capped moulding head, slotted moulding head, circular saws, boring bits, routing bits.

The countershaft has fast and loose pulleys, ten inches diameter, for a four-and-a-half inch belt, and should make seven hundred and fifty revolutions per minute. It requires to be placed on the floor with the centre five feet from the centre of the machine base.

The machines are made in two forms, varying only in the arrangement of the sliding-table for the sawing operations.

The one illustrated has the accurately fitted table of iron, while the other has a wooden slide. In all other details the machines are the same.

The weight of the machine is eighteen hundred-weight, the floor space occupied ten feet by eight feet. Power required, about two horse-power.

Description of the Various Operations for Slitting and Cross-cutting.—The saw is placed on the spindle, a long collar being fitted brings it to the right position on the spindle. The saw is raised and lowered through the table by the hand wheel seen at the front. The table on the right of the saw is stationary, and has the gauge for guiding the wood in slitting. The gauge bevels to any angle, and is moved to and from the saw approximately by the hand, when it is clamped and adjusted for accurate distances by the screw and hand wheel at the back of the machine. This gauge also acts as a stop for gauging any fixed lengths in cross-cutting, tenoning, &c. For examples of operations, see illustrations.

For Planing out of Wind.—A cutter head, twelve inches long, is slipped on the spindle. This cutter-head is made with back lips to support the cutting edges, which are of the class termed "skew" cutters. After the cutter block is clamped firmly, the spindle is adjusted so that the cutter edges are level with the back table. The front table is then lowered to suit thn depth of cut required. By means of special mechanism this table is kept an equal distance from the cutter edges as it is lowered. Timber of any length and depth up to twelve inches wide can be planed to a true face. The piece is held firmly against the gauge, which can be canted to any angle.

Tapering.—The tables and cutter head remain the same, but in starting the wood, one end is rested on the edge of the back table. If more taper is wanted, the operation can be repeated.

CORNERING.—The back table is kept in the same position, but the front table is lowered to the depth the corner is desired to be cut. The gauge is set at the angle desired to support one side of piece. See Figs. 100 to 103.

CHAMFERING.—In this operation the front and back tables are set level, and the cutter block is raised above the table to the depth required to chamfer. To produce uniformity in the pieces being worked, stops should be placed to gauge the length of cut. The end of the wood should then be held firmly against this stop, while it is lowered on to the cutters, and rests on both tables. See Fig. 40.

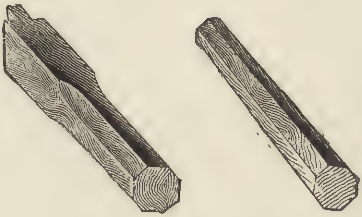


Fig. 40. CHAMFERING.

JOINTING AND MITREING.—The gauge is set to correspond to the right angle, and the front table lowered to the required depth. See Figs. 106 and 107.

REBATING.—In this operation the cutter block is a narrow one, the opening in the table being filled up, except the required opening for the cutter head. The tables are set level, and the cutters project through the table to the required depth of cut. The wood is guided by the gauge at the back. See Figs. 43 to 45.

MOULDING.—The tables remain level while different cutter blocks are fixed on the spindle for the purposes. The opening in the table is filled on each side of the cutter.

TONGUEING AND GROOVING.—The tables remain level as before, and the matching heads are placed on the mandrel, the gauge forming a guide for the back head, and a temporary gauge, placed on the front of the machine, answering for the other head. By placing the gauge at an angle, tongues and

grooves can be cut to any angle. The material can be tapering and of various widths, the difference requiring no extra adjustment. See Fig. 40.

PLANING RULE OR TABLE JOINTS. — This operation resembles the hand matching, except that suitable cutters are substituted on the spindle.

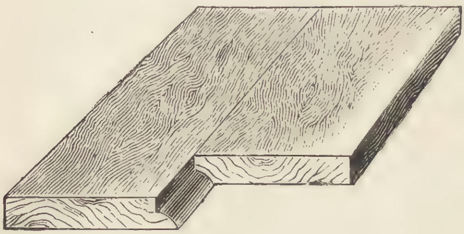


Fig. 41. RULE OR TABLE JOINT.

PLOUGHING. — The tables remain level, and the spindle receives the cutters of suitable width. Two or three grooves can be cut at one time if necessary. See illustrations.

PANEL RAISING.—The tables remain level, but are drawn far enough apart to admit the cutters. A wooden gauge is attached to the one on the table, by bolts passing through springs placed between them, thus giving a flexible pressure for inequalities in thickness. A front gauge is attached to the T slot of the outside table. Special heads of any diameter, for special requirements, made to order. See Fig. 42.

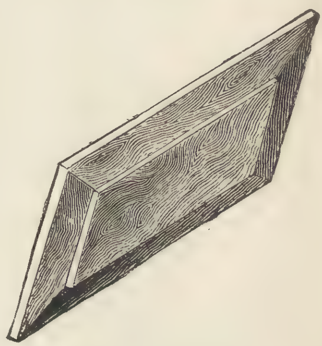
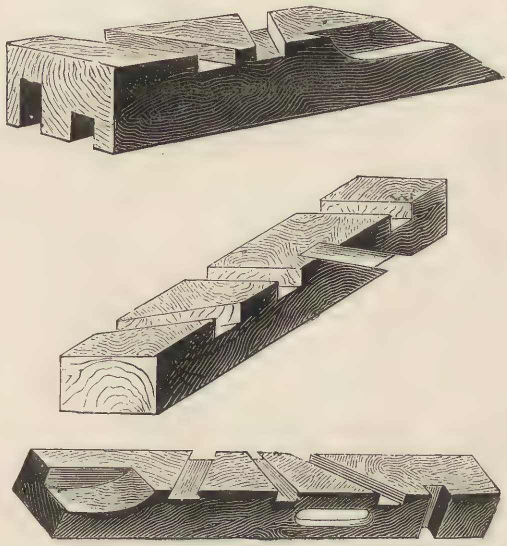


Fig. 42. PANEL.

TENONING.—For this operation the sliding table is brought back to its position after the tenoning cutter has been fixed on the spindle. A special clamp is used to hold the wood down, and the depth of the tenon is regulated by adjusting the spindle vertically. The gauge on the front

table is moved up to act as a stop gauge for the length of tenon. A tenon is shown at Fig. 40.

CHECKING, GAINING, &c.—The same arrangement of machine is used as above, the pieces being clamped to the



Figs. 43, 44, 45. EXAMPLES OF CHECKING AND GAINING.

folding table. Different widths of cutter heads are used. The gauge on the sliding-table can be altered to any angle for angle checking, &c. See above illustrations.

The Britannia Company has recently brought out a patented machine for sawing, worked by a treadle, as shown in Fig. 46. This saw is a great economiser of time and of labour. It is said to save its cost every year that it is in use. Dowelling, grooving and boring can be accomplished in addition to the ordinary work of a circular saw. The capacity of the machine is four inches thick, it runs one thousand five hundred revolu-

tions per minute—has adjustable mitre and cross-cut gauges, boring attachment, &c. Wood an inch thick can be sawn at the rate of ten feet per minute.

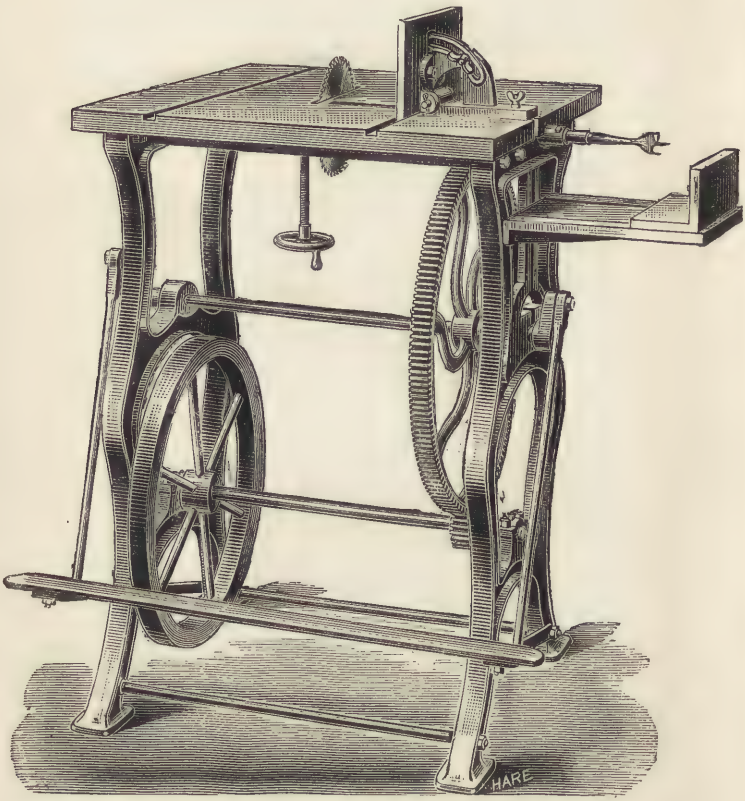


Fig. 46. CIRCULAR SAW FOR FOOT POWER.

The scroll saw attachment shown at Fig. 47, is intended for use with the machine last illustrated. The arm is hinged to the wall or ceiling and is entirely out of the way when not in

use. When let down, as shown, it allows a thickness of four inches to be sawn and the dimensions of the material are

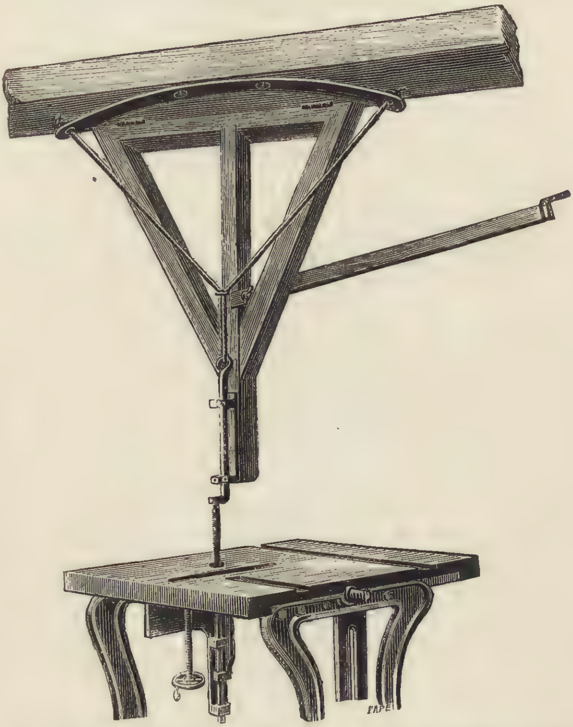


Fig. 47. SCROLL SAW ATTACHMENT FOR FOOT POWER MACHINE.

otherwise limited only by the size of the room in which the machine is used as the table is quite clear.

CHAPTER VI.

TURNING, AND TOOLS USED.

THE ordinary wood-turner who works at the foot-lathe employs but few edged tools except chisels and gouges. By the aid of these alone nearly all external turning is done. The cutting edges of tools used for turning soft wood are found to act best when ground to an angle of about twenty-five to thirty degrees. This gives a keen edge, capable of withstanding the ordinary usage of such work. To work with tools which are ground less acutely is like cutting wood with a cold chisel—and here it is as well to explain that a cold chisel is the name by which chisels used for cutting cold metal are known.

The great care of the ordinary wood turner is to make his curves graceful and blending—for this he will sacrifice dimensions. The pattern maker cares not for the appearance—that has been decided before the work comes into the lathe. He tries cylinders with the straight edge, and turns curves by template, his stoppages are frequent, for both size and shape must be correct. The work is finished by scraping with various shaped special tools, but, with the exception of the gouge for roughing, and the chisel, they are all scrapers. An ordinary paring chisel, whetted upon an oilstone will be found to have a slight bur raised upon that side last to be touched upon the stone. The chisel is now fit for scraping, or finishing pattern work in the lathe. Round-nosed tools, side tools, diamond point tools are all sharpened in this manner.

In turning large discs, some trouble is often experienced, from the jar or vibration of the work as soon as a scraping-tool is applied. A point will not cause this vibration; therefore, the diamond point is used for truing the surface of large work. One cannot easily produce a flat surface with a point-tool, therefore it is better to use a tool made from a chisel, say one-and-three-quarters of an inch wide. Having softened it, a series of **V** grooves about ten to the inch along its face, they should not be all of the same size or depth. Re-temper the chisel and grind it only on the bevelled side. This chisel will true up very slender work and make a surface, if necessary, ready for papering. This toothed chisel, like the plain chisel, if used for turning, should be slightly rounding, so that its breadth does not all bear on the work at once.

Cylindrical work, which includes so many patterns, is first roughly turned to shape with the gouge, and then the chisel is brought into requisition to smooth and finish the work. The same description of tools are employed for turning flat surfaces, both plankways and endways of the wood. Hollows and internal recesses are also turned with gouges and chisels whenever there is sufficient space for their introduction.

The correct position for the cutting edge of the tool is at a tangent to the circle which it is turning—that is, the circle left after the passage of the tool; and it is only necessary to thoroughly understand the meaning of this to be able to place the tool with precision and certainty in the best possible position for cutting. A tangent is a line which touches, but does not cut into the circumference of a circle, and the chamfer ground on the convex side of the gouge has to form a tangent to the circumference of the diameter being turned. It must be perfectly understood that a tangent may be formed at any point of the circumference, and equally well at the

highest or lowest point. It is generally said that the height of a tool should be exactly of the same height as the lathe centres, and though this is perfectly correct in the case of slide-rest tools as usually ground, yet the axiom has no bearing if applied to hand tools, though in turning metal the same rule is advisable, as it affords a rigid rest at the most convenient place. No matter at what height the rest is fixed, the tool can be placed at a tangent to the work by elevating or depressing the handle as may be required.

To make the action of turning tools clear, so far as their cutting edges are concerned, I will borrow from "Lathe-work" a diagram which shows two tools correctly applied for cutting both soft and hard material. By this it is seen that the slide-rest tool, with a strong cutting edge suited for operating upon highly cohesive metal, such as steel, and the acute wood-turning chisel, suited for the softest material, have each the lower face-angle placed in the same position with regard to the work. The upper face, which wedges back the shavings, curling or breaking them according to the nature of the material operated upon, is the only one in which any difference is observable agreeable to this latter condition.

In Fig. 48 the line of centres is shown by *a*, *b*. It is precisely to this height that all slide-rest tools should be set. With hand tools it is of little importance whether they be applied above, below, or on the line of centres. The edge of the metal-turning tool is formed by the meeting of the faces *a*, *x*, and *d*, *x*; *d*, *x* is three degrees from the perpendicular, and this gives the angle of the edge as eighty-seven degrees. The edge of the soft wood chisel is formed by the meeting of the faces *c*, *x* and *d*, *x*, enclosing twenty-five degrees, still keeping the lower face in the same line, that is a tangent to the circle.

Suppose the tool is laid on to a true cylinder, so that its bevel forms a tangent to the cylinder, it cannot cut the material; but directly the handle is raised the cutting edge is depressed into the cylinder, and all that material lying outside of the diameter of the edge is removed. The position of the cutting edge is best determined by the sense of touch, the tool being laid on the T rest with its end overhanging the work considerably. The lathe being in motion, the tool is then drawn gradually towards the operator, all the while

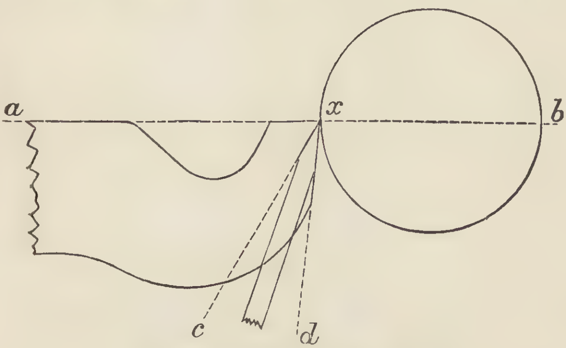


Fig. 48. Cutting Angles of Tools.

keeping it resting on the cylinder, till the edge reaches the point at which it forms the tangent, and then it commences to cut. By slightly tilting the tool, the edge is brought to act on a smaller diameter, and turnings are removed under the most advantageous circumstances.

Apertures which, in comparison with their depth, are of small diameter necessitate the use of tools of special form, which are, generally speaking, hook-shaped. Tangs of various forms and dimensions have the ends bent to form gouges and chisels, so as to be available for work where the ordinary straight gouge or chisel could not enter. To attain efficient mastery over these hook tools requires considerable practice.

In the hands of inexperienced persons their application frequently leads to mishaps. A strong wrist and, above all, practice in using the tool are required, in order to counteract the powerful leverage exerted by the work, which tends to twist the tool and wrench it from the grasp.

The length of handle is an item of importance in all hand tools, as reflection will show. They are all, when in use, governed by the laws which act on a lever, the fulcrum being the point of support on the rest, the cutting edge then terminates the short arm of the lever, and the power over it is proportionate to the length of the handle end as compared with the length of the short end. The control over the tool is therefore greatest when the rest, and fulcrum point, is nearest to the work, and the hand holding the handle is nearest to the end. When the handle is not sufficiently long, the edge of the tool is liable, when caught by the work, to be drawn into cutting too deeply, through the hand not having complete control over it, and, from the same cause, with greater force, the tool will be twisted out of the grasp, or the work forced from the chuck. In order to give greater freedom in the movement of the cutting edge, tools used for wood-turning, which are generally required to do a long range of surface, they are used with the rest placed at some distance from the work, and this, in giving longer motion to the cutting edge, gives a much greater power on the leverage: and it is for this reason that such tools require to have long handles.

Gouges for turning are made in all sizes, having cutting edges from one-eighth to two inches. The sectional form varies from crescent-shaped tools, with a thick back tapering to a thin edge, to circular ones, in which back and edge are of equal thickness. The curvature of the tools varies also greatly: from those in which it is so slight that they may almost be considered straight-edged to others having a semicircular edge.

The length of gouges is partly governed by their size, one inch gouges measuring generally from ten to fifteen inches long.

The ordinary gouge and chisel used by the wood-turner must not be confounded with those tools having the same names but used in cabinet making and joinery. The carpenter's and the turner's gouges are quite distinct tools, though they have a general similarity; and the same may be said of the chisels used in the respective trades. The turner's gouge is a much stronger tool, having more metal in it than its namesake; it is ground to a different shape, and has a handle from eight to sixteen inches in length, according to the size of the gouge. Fig. 49 illustrates a gouge handled complete. Both tools are ground on the outside of the curvature, but the turner's

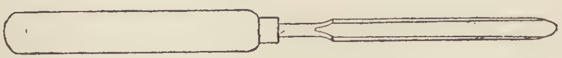


Fig. 49. A Turner's Gouge.

gouge terminates in a rounding edge, without corners, instead of being square with the shaft of the tool. This round form of edge is necessary in order to obliterate the sharp corners, which would be liable to catch in the work. It also allows the most prominent parts of the edge to be used in grooves which are comparatively narrow. Very small curves and mouldings can thus be easily operated upon by small gouges.

Several sizes are always provided for use, and whilst the larger ones take off large shavings and rough the material to shape quickly, the small ones are available for more minute work, and may be used for turning in shoulders to very nearly an acute angle.

Chisels for turning are made in sizes to correspond with the gouges, but larger ones can also be procured. They resemble ordinary paring chisels, but have no shoulder to the tang, the edge being also formed very differently. The blade of a turner's

chisel is bevelled equally from each side, leaving the cutting edge in the centre of the thickness and at an oblique angle with the sides. This angle is usually about seventy degrees and one hundred and ten degrees, instead of being square across like a paring chisel. Turning chisels are ground obliquely, for the sake of greater convenience in use. One of ordinary shape performs the work equally well, but, as that tool has to be applied at an angle to the work, which is often inconvenient, an oblique edge is preferable, allowing, as it does, a cylinder to be turned with the tool at right angles to the axis of rotation.

The method is the same for applying both gouges and chisels. The tool is grasped firmly near the cutting edge by the left hand, the knuckles being uppermost. The right hand holds the handle near the end, and, to afford greater steadiness, it usually rests against the side of the body. Thus held, the tool, if a gouge, is laid on the T-rest with its convex side downwards. The edge is brought sufficiently near to the revolving cylinder to touch it in the position of a tangent; that is to say, a straight line, drawn in continuation of the ground bevel of the tool, will touch, but not cut into, the cylinder. In this position the gouge will not cut, but by raising the end of the handle with the right hand, the edge of the tool is depressed, and it then comes in the position of a tangent to a smaller circle. When the work is rotated, all the material outside of that diameter will be shaved off by the tool. During this process the pressure on the edge of the gouge tends to force the tool deeper into the work; the right hand must, therefore, hold down the handle till the work has been reduced all round to the new diameter.

The first cut of the gouge is usually made at a short distance from the right-hand end of the rough balk, and when a groove is turned the tool is inclined towards the left, so as to remove

the material between it and the end. A new cut is then made towards the left, and this is made continuous with the previous one by inclining the point of the gouge as before; thus by a continual shifting of the tool, and turning a small distance at a time, the entire cylinder is brought roughly to form. The size is gauged by means of callipers, and if much in excess of what is required a further application of the gouge is the best way of reducing it; and the cylinder is made as straight and even as possible by this tool before employing the chisel. In this levelling operation the gouge is slid along the top of the T rest, guided by the left hand, and tracing on the work a regular spiral path. An expert hand can by this means produce a very tolerable smooth surface to the work, the gouge being traversed from both ends alternately, and the parallelism is checked by callipering.

The chisel used for smoothing the work is applied similarly to the gouge, and all that has been said applies to both tools, subject to any modifications rendered necessary by their different forms. The chisel is always applied so that its edge lies obliquely across the surface of the cylinder, the handle being also slightly inclined to place the edge of the chisel—which is, as has been already stated, ground obliquely—at a slightly greater angle with the line of centres than that it makes with the chisel blade. The tool is laid on the rest, with the blade resting on one corner of the obtuse angle. The chisel is tilted up sufficiently to bring the central part of the cutting edge against the work. Only the central part touches, both corners being free, the edge lying obliquely across the cylinder. If either corner were allowed to act on the work it would be extremely difficult to guide the tool, which would have a tendency to "catch in." This tool is held with the left hand grasping the blade close to its cutting end, with the knuckles above; the right hand grasps the handle near to its end, holding

it near to the right hip, and the chisel blade rests on the T, one of its lower corners only in contact. The tool is slid along with the obtuse angle leading, and may be used from either right or left. To reverse the direction it is only necessary to turn over the tool.

Through the tool being presented with its edge obliquely, only the central part cuts, the two corners not coming in contact with the work, and the extreme central part cuts deepest, the shaving cut by the chisel being thickest in the centre and tapering off on each side to a feather-edge. By carefully considering this, the necessity of correct tangential position will be better understood. If the chisel is laid on to cut with the entire breadth of its edge, the tool becomes unmanageable from the quantity of material it has to cut. The production of straight, level work will depend on maintaining, during the entire longitudinal traverse of the tool, a perfectly equal amount of tilting from the T, and the same relative position of the handle held in the right hand. It must be remembered that the chisel lying obliquely across the surface of the cylinder, and forming a tangent to it, will not cut at all, acting just as a gouge under the same conditions; but directly the handle is raised, and the edge penetrates the diameter, then the tool lies at a tangent to a circle of smaller diameter, and all material outside of that circle will be cut off. The cut is taken from either end, as most convenient, by simply turning over the tool. The principles which govern the cutting action of the gouge are equally applicable to the chisel, and it is by tilting up the handle that the tool is fed into the cut.

Fig. 50 represents a gouge of the form in general use; it measures nearly half-an-inch on the edge. The section shows much less metal than is embodied in Fig. 52, and this kind of gouge is much lighter and handier in many respects than the one shown at Fig. 52. The grinding is more easily accom-

plished. The substance of the tool is quite adequate to the requirements of all ordinary wood-turning, and it is with gouges of this form that most work is done. Larger sizes, from one inch to one-and-a-half inches, are used for roughing-down purposes. The section of this tool is crescent-shaped; the centres of the two circles, whose arcs form the concave and convex sides, are about one-sixteenth of an inch apart. The points of the horns are rounded off, so that all sharp corners are avoided. The convex surface has a radius of a quarter of an inch, the concave being only one-thirty-second less. From these measurements, taken from a gouge by the

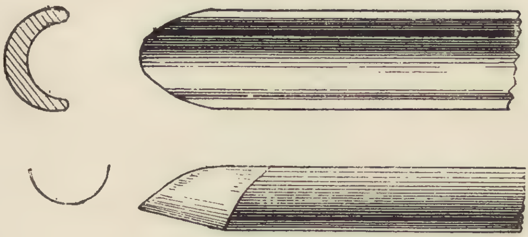
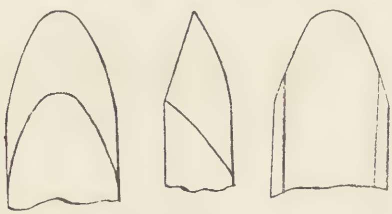


Fig. 50. A HALF-INCH GOUGE.

aid of which I have made many a bushel of shavings, the precise form of the tool may be easily understood. The bevel ground around the convex part very much resembles that of the following figure. The elliptical form of the edge is more circular, owing to the larger channel in this tool. After what has been said in connection with the chisel, it is scarcely necessary to mention that the angle enclosed by the bevel and the inner surface should be about twenty-five degrees. Tools for soft wood turning are seldom more than thirty degrees on the edge.

The accompanying cut, Fig. 51, shows three views of the cutting end of a turner's gouge, and are intended to illustrate the method of grinding. C is the front, or concave side, of

the gouge, and shows the parabolic curve of the cutting-edge B is the side, and shows the long sloping chamfer made by grinding the tool. The angle formed by this chamfer should be from twenty-five to thirty degrees. It is this chamfer that should form a tangent to the work when the gouge is in use. A shows the back, or convex side, of the gouge, and the chamfer will be seen to be of equal slope all round. In setting gouges, the turner has an ordinary oil-stone, with a number of different-sized, semi-circular groves worn into it. A groove the size of the gouge is selected, the back or chamfer



A BACK. B SIDE. C FRONT.

Fig. 51. GRINDING A GOUGE.

part rubbed along it, at the same time turning the tool slightly, as when grinding. Then with a slip of oil-stone having a rounded edge, the wire-edge, which will be found all round the cutting edge in the hollow side, is removed. In doing this great care must be taken to rub the burr down only level with the surface on the hollow side, because tilting up the back end of the slip would produce a slight chamfer on the hollow side of the tool, and this is not desirable. The operation, however, turns the wire-edge backwards, when the tool must again be lightly applied to the hollow set-stone; and, finally, one or two more rubs on the inside with the slip, after which it is wiped with a piece of soft leather, or on the palm of the hand, which removes any remaining wire-edge, and the tool is now ready for work. All the gouges, large and small, are

ground and set as described above, different-sized slips being used.

Fig. 52 shows a quarter-inch gouge. Top, side, and sectional views being given, the small semi-circle shows the size and form of the cutting-edge. This kind of gouge is particularly strong, as can be seen from the sectional view, there is only a small channel as compared with the substance of the tool. The bevel formed by grinding is shown in the side view; and the form of the point, seen from the top, illustrates the correct form for grinding. There are no sharp angles, the point ends

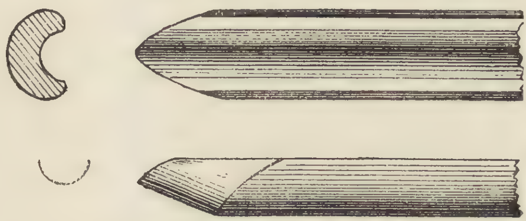


Fig. 52. A Quarter-inch Gouge.

in an elliptical edge, leaving the centre most prominent. The horns of the crescent-shaped section are thinned off on their outer sides, to save metal and leave less to be ground away. Both the inside and the outside curves are circular, excepting the part just alluded to; the centre of the smaller circle is, however, fully a sixteenth of an inch from the centre of the convex face.

Fig. 53 represents a three-quarter inch chisel; side, top and end views are given. The two bevels, which meet at the cutting-edge, enclose an angle of twenty-five degrees. This, as will be seen by the diagram, Fig. 48, is the angle suited for wood-turning tools. The oblique edge forms at each corner angles of seventy degrees and one hundred and ten degrees respectively, as has been mentioned previously. A chisel of

the size illustrated will measure from about eighteen to twenty inches from end to end, when handled ready for use, the

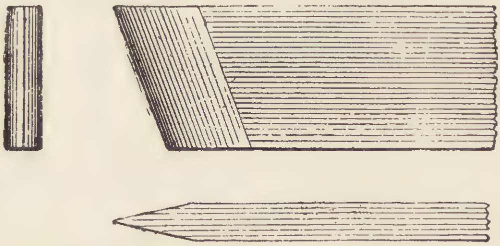


Fig. 53. A Three-quarter-inch Chisel.

blade being about half that length. The rectangular figure, facing the cutting-edge, is a view of the end.

Fig. 54 illustrates a hook-tool used for turning interior hollows. The steel shaft is forged out thin and wide at the

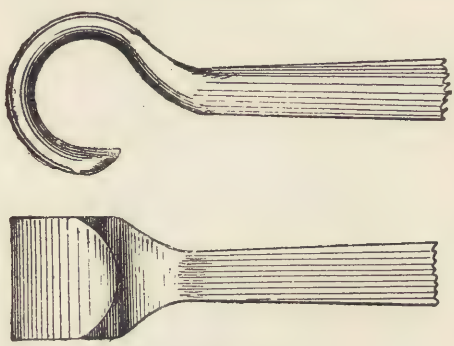


Fig. 54. A Hook Tool.

end, and curled into a circular form as shown. The outer part of the circle is ground square with the tang; the inner side is thick in the centre and bevelled towards both edges. This makes a sharp cutting-edge around the ring, as shown in the top view. The tang itself is square in section, with the

corners bevelled off; near to where the hook commences it is nearly round. These hook-tools are carefully filed round the inside to form a smooth bevel; all the corners are rounded off, and the tool is then hardened and tempered for use. It may be applied to the work either side up, and considerable manual dexterity is required in its use to prevent accidents of a more or less serious nature.

The other necessary tools for ordinary wood-turning are but few, and consist of callipers, a pair of compasses, two or three slips of oil-stone for setting up the gouges, a side tool and a parting tool. Fig. 55 shows a large scale view of the side and edge of an ordinary parting tool. A grindstone and an oil-stone are also very useful, and, in practice, the use of these cannot well be dispensed with. There should be about half-a-dozen pairs of callipers of various sizes, the largest opening to about twelve inches to fourteen inches. Also one or two pairs of inside callipers, these being too well known to need illustration.

Fig. 55.
PARTING TOOL.

The parting tool is in shape like Fig. 55, about five-eighths of an inch broad and one-eighth of an inch thick. It is used for cutting off pieces of finished work from the block, held in the cup chuck, or on a face plate, such as bosses, patellas, draught-men, &c. It works best when the grain of the wood is running at right angles to the lathe centres, that is plank-ways.

The above tools are about sufficient for most purposes. There are, however, a variety of other tools of peculiar forms required by turners who do a great variety of work. The shape of these suggest themselves from the nature of the work to be done. Old files of various forms are often utilised by grinding into the required form. In the grinding of all

tools, see that the ground part, or chamfer, is a straight line from the heel to the cutting-edge; and in setting on the stone this surface should lie nearly close on the stone, the heel only slightly raised, so that the cutting-edge comes in contact with the stone. If the handle end is held much higher, a new chamfer is immediately formed at a more obtuse angle than the ground part, and the tool will not work satisfactorily until it is re-ground.

The first actual turning is done with the gouge, and large ones are used for large rough work. The correct angle for grinding the gouge, and the proportion of handle have been previously mentioned. The rest is placed just clear of the revolving work, and the **T** adjusted to a convenient height, so that when the cutting-edge is performing properly, and the tool resting on the top of the **T**, the handle will come to a convenient place at the right-hand side. The height of the rest is therefore generally to a certain extent governed by the stature and habit of the workman.

CHAPTER VII.

LATHE CHUCKS.

THE appliances used for attaching the work to be turned to the lathe-mandrel are called chucks. They usually screw on to the mandrel nose, but sometimes this has an internal thread, and there are other means of attachment. Chucks are used in wood turning according to the kind of work to be performed, but the hollow chuck, the cone screw chuck, and the prong, or strut chuck, are almost indispensable to all turners. By the aid of these three chucks the bulk of ordinary turning is performed. They should be made of metal, this being greatly superior to wood, while the difference in cost is comparatively slight. Many turners use chucks of beech or box. It is the best plan to have the three chucks above mentioned made of cast-iron, and then prepare pieces of beech to fit the hollow and the screw chucks. If metal chucks are not used, boxwood should be used and not beech. It may be here mentioned that for iron chucks a male mandrel-thread is best, but for wood chucks a female mandrel is often preferable.

The prong chuck, Fig. 57, is used for every kind of wood-turning, when the work is supported by the back centre. The most simple chuck of this description is made by driving a prong into a wood chuck. The prongs are sold at tool-shops ready forged to shape.

The ends usually terminate in a plain knife edge, which is diametrically across the prong. This form is wrong in prin-

ciple, and generally unsatisfactory in use. The wedge-like edge, when forced into the end grain of the wood, tends to split it, and this usually results when the prong is applied incautiously. The illustration, Fig. 56, shows the prong made as it should be. A metal chuck is first prepared, and the steel prong, only roughly shaped, is driven into it. The central pip is turned up true on the lathe; it it shaped conically, as shown. Two opposite sides of the prong are then made flat by filing; they taper from about half an inch wide at the back to about three-sixteenths or one-eighth of an inch on the front edge. The two edges are bevelled from the back only, so as to resemble a

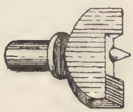


Fig. 56. PRONG.

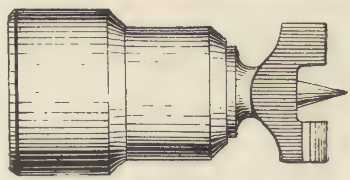


Fig. 57. PRONG CHUCK.

carpenter's chisel. Prongs of this shape hold the work more firmly, and are not so liable to split it as those having a straight wedged-shaped edge. Each prong holds at an independent place, and any tendency to split is distributed at two quite distinct points. The central pip is intended to keep the work central, and the prongs are to carry it round. It is necessary that the pip should run true, so that the work may be replaced true if removed from the lathe.

In use, the prong chuck is first imbedded in the work only so far as the pip extends beyond the edges of the prongs. The back centre is brought up to support the opposite end; the lathe is set in motion, and the work set true. The work is then driven on to the prong chuck by means of a mallet, sufficiently to firmly imbed the prongs, and the turning may then be proceeded with. All kinds of wood-turning done

between centres are most frequently driven with the prong-chuck, and it is only in special cases that other chucks are used. When large numbers of square pieces are to be operated upon, a square-hole chuck, such as has been described, is better, because it saves time in chucking the work.

The next chuck illustrated is the conical screw-chuck, Fig. 58. This chuck is used for turning all kinds of wood plankways of the grain, when a central hole is allowable. The back centre is not used as a support for work mounted on this kind of chuck.

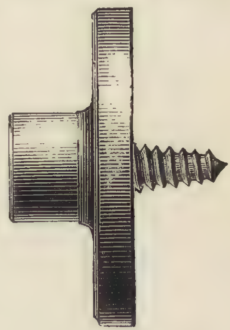


Fig. 58. CONICAL SCREW CHUCK.

The body is made usually of cast iron, but sometimes of brass, gun-metal, &c. It may be from two to four inches in diameter for a five-inch lathe. The front face must be turned quite flat and true. The conical-screw is of steel. The thread should be coarse and thin, similar to the thread of an ordinary wood-screw but conical. A special screw tool is necessary for cutting conical threads, in order to make them upright. If cut with the ordinary form of chaser, the thread would lean forward very much, and would have but comparatively slight hold on the wood into which it was screwed. The steel cone may be fixed into the casting by driving in from the back, or a fine thread will hold it very well, but it must be screwed very tight, and sometimes has to be riveted at the back to prevent the screw being removed when unchucking work.

Fig. 59 shows the form of comb-screw tool suited for cutting the thread of a taper-screw so that the thread is itself upright. The teeth are cut in a slanting direction, and those cutting the small part of the cone have their points ground off.

Different sizes are employed, according to the dimensions of the work to be turned; two or three are sufficient for most purposes. To mount work on this chuck a hole is bored centrally, and of a size and shape suited to the dimensions of the cone-screw. A conical, half-round bit, such as is commonly used in the carpenter's brace, is a useful tool for this purpose. The wood is screwed on to the cone screw direct, the chief consideration being to get it flat against the face of the chuck. When this is secured, the work may be taken off and replaced tolerably true. Discs of wood, which would be spoiled by having a hole in them, are frequently mounted on the cone-screw chuck by being first glued or cemented on to another piece of wood, which is bored and screwed on to the chuck. If the surface of a piece of wood fitting the chuck is turned true, and the work to be turned has one of its surfaces planed flat, the two may be fixed together by glueing, and when finished the separation is easily managed with care. It is, perhaps, the best plan to make the joint with a piece of paper glued on both sides. This allows easy separation.

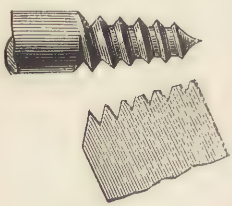


Fig. 59. Screw Tool for Cutting Thread on Cone.

Work of large dimensions is sometimes further secured on the cone-screw chuck by putting wood screws through the flange into the work, holes being bored through the flange to receive such screws. An ordinary wood screw is sometimes used for the central screw, but it is not nearly so strong as the steel screw, illustrated. For some purposes, when the central screw is objectionable, a disc of wood may be held on a flange by three or four wood screws, the central screw being dispensed with.

The two chucks illustrated afford the means of dealing with

wood in the form of both rods and discs, and they are those in most general request by the wood-turner.

The next illustration, Fig. 60, shows a spring-chuck which is employed to clamp small pieces of wood. This chuck is practically self-centring, and is the kind used by pipe-makers and others ; it is suitable for chucking tobacco pipes, &c. The drawing shows a chuck with six grooves, but the number is immaterial. Some workmen use those with only one saw-cut, dividing the chuck into two parts, giving only two jaws. This is undesirable, as the work so chucked is not held firmly. Three jaws would act very well, but it is difficult to cut only three saw kerfs, and for that reason six is the number more generally made. Good sound boxwood is the best material from which to make such chucks, and at the termination of each saw-cut a hole should be drilled. This not only lessens the liability to split, but also, by decreasing the amount of material near the butt end, makes the chuck more flexible at that point—a desirable quality.

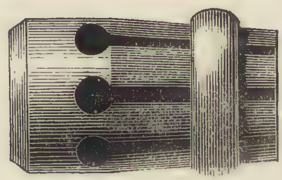


Fig. 60. BARREL CHUCK.

In order to ensure the jaws bending near to the butt end, the interior of the chuck should be hollowed out where the holes are bored. This method of reducing the substance of the wood is a better one than that of drilling large holes, because it reduces the strength in the right direction, and does not make the chuck weak, as is the case with large holes.

The outside of this chuck is turned slightly conical, so that the metal ring, shown in Fig. 60, when forced on it closes the points of the jaws, thereby gripping any work that may be placed within them. The range of motion in the jaws of this

form of chuck is not very great, and hence it becomes necessary to have several spring chucks in accordance with the various sizes of work to be executed. In order to prevent the wood from splitting, an iron ring is often put around it at the butt end.

It is important to see that the ring which binds the staves together runs true, as, if otherwise, the jaws are brought together unequally, and the work chucked in them will be eccentric. The inside of the ring should be rounded, so that its edge will not catch and cut into the surface of the chuck.

To use this chuck, the ring is first pressed on to the jaws moderately tight, so that it holds them firmly. A recess is then turned in the end very slightly smaller than the diameter of the object to be chucked; the ring is then pushed towards the front end, thereby allowing the jaws to open. The work is put into the previously turned recess, and there securely fixed by pushing the ring back till the jaws clip it firmly. The ring is often driven on by slight blows at various points of its circumference, always remembering to get it to run quite true.

This chuck is used principally for work which has already been turned true at some part, by which it may be conveniently chucked. When a large quantity of objects are to be turned, the dimensions of which are approximately the same, this chuck is the most useful in place of a solid wood chuck, in which it would be impossible to fix any but those of exactly one size. As an example, a set of men for draught playing would be chucked with the greatest ease in a spring-chuck, of the pattern illustrated, for the purpose of ornamenting one of their sides. Some objects with a projecting piece are most easily turned in this chuck. The bowl of an ordinary briar-root tobacco-pipe may be chucked for boring by merely

cutting away a space to allow the stem to be free of the jaws.

In the next figure is illustrated a chuck specially designed for turning discs having central holes; or it may be used for mounting any work which has a true hole in its centre, the diameter of which is sufficient to allow the screw shown in Fig. 61 to pass. Numerous central screws of different lengths and diameters to suit various objects may be fitted to such a chuck as this. Plain steel spindles, with a thread at the extremity only, are stronger than those with a thread cut all their length; but they do not afford so great a range.

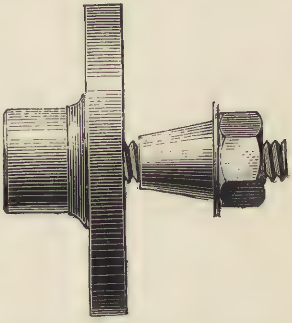


Fig. 61. Chuck for Turning Discs.

The body-part of Fig. 61 is the same as the cone screw-chuck, Fig. 58. It must be faced up true to afford a bearing for any discs mounted on it; and in the centre it has a hole to receive the screw shown projecting with a cone and nut on it. This screw is an ordinary bolt-thread cut on steel, and must be quite straight. The length will be governed by the work it has to do; those from two to six inches are commonly employed. The diameter is restricted by the size of the hole in the work; otherwise it is well to have it large enough to be quite stiff under the heaviest cut to which it is likely to be subjected. The cone shown is bored to fit without shake on the thread, and must be turned quite true, as it is by its outside that the work is centred. Hard wood is frequently sufficiently durable for cones, used only for light wood work; but metal is better, and when the chuck is used for metal work, metal cones are necessary, and they are often made of steel. Any number

of cones may be made to fit on one screw, and several are required to suit holes of different sizes.

An ordinary hexagon nut is used to force the cone up to its work, a plain washer being interposed between it and the outer edge of the cone. It will be understood that the disc mounted on this chuck is kept flat by the face of the flange, which also bears against the work with sufficient friction to carry it round with it, and will hold firm against any moderate cut.

The centrality of the disc is maintained by the cone, which bears against the inner edge of the hole in the work, and is kept there by the hexagon screw-nut. The cone itself penetrates the work till its diameter is greater than that of the hole; it then wedges the disc against the flange. This wedging force is liable to split wood which is not very tenacious, though it is not in any way detrimental to metal; and some hard woods will stand well under the pressure.

To secure wood that would be split by forcing the cone in far enough to wedge sufficiently tight for turning, another piece is fitted to this chuck. This may be thus described. The screw must be considerably longer for using this piece, which consists of a cup-like casting, the hollow of which is sufficiently large to contain the hexagon nut and projecting portion of the cone. The bottom of the cup is bored to accurately fit the screw, and the edge is turned flat and true; another nut has to be provided similar to the one shown, its purpose being to force the cup against the work on the chuck. To use this extra piece, the disc is first mounted in the manner already described, with the cone screwed up just sufficiently tight to keep the work central. The cup is put on next with its edge resting against the disc. A nut being screwed on behind the cup causes its edge to grip the work and wedge it against the face of the flange. By this arrange-

ment a disc may be secured quite tightly, without in the least tending to split it. The broad surface of the flange will not indent any but very soft material, and even this can be protected with a disc of cardboard. The edge of the cup may also bear on the work through an interposed piece of wood, so that it will not mark finished work.

Fig. 62 shows a modified form of the chuck illustrated by Fig. 58. The conical screw is replaced by an ordinary wood screw, and a couple of other wood screws near the edge of the disc further secure the work.

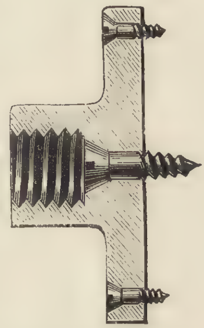


Fig. 62. Modified Conical Screw-Chuck.

A fully-equipped lathe has a lot of accessories, but a pattern maker doing only ordinary work may get along comfortably with very few of these. A six inch and a nine inch face-plate, and one or two cup-chucks in addition to those already illustrated, are about sufficient. The face-plates are made to screw on to the nose of the mandrel. The six-inch face-plate should have a conical screw in the centre, with a coarse deep thread about five-eighths of an inch long; the plate has also a number of holes to admit screws to fix the work from the back; but discs up to the size of the plate, and even larger, do not need these screws, the central one being sufficient.

The nine-inch face-plate should have a very small, sharp conical stud in its centre and be truly central; the work is centred on this stud, and fixed with screws through the plate. This face-plate comes in frequently in pattern-making.

Two cup-chucks are necessary, one about two inches, the other about four inches diameter, and from one-and-a-half inch to two inches deep. They are used to hold pieces of

wood that have to be manipulated on the end projecting from the chuck, and that could not be held on a face-plate. The smaller cup-chuck is often used as a drill-chuck. The turner fits a number of pieces of hard wood to this chuck: in the centre of each he drives a drill or boring bit firmly; all bits are thus provided with wooden blocks, and these all fit the cup-chuck. The turner selects the bit or drill he wants, inserts its block in the cup-chuck, gives the block a few taps with a hammer while the lathe is running, and the bit is immediately set true.

A few taps on the side of the block, which projects about an inch out of the cup, release it from the cup; or the lathe is run backwards, thus allowing the cup to screw off the nose, and the block with its bit are driven out with a round pin of wood through the screw-hole at the back.

CHAPTER VIII.

CORE-BOXES AND PILLOW-BLOCK PATTERNS.

CORES are internal parts which form a hollow in the casting. Core-boxes are used for forming cores, and illustrations of boxes used for making round and square cores are given below. The drawings, Figs. 63 and 64 are so clear that verbal explanation is unnecessary. For making a core the two halves of the core-box are clamped together, and the cavity filled with core sand, rammed in tightly, so that on separating the halves a solid core of sand is found, as shown in the illustrations.

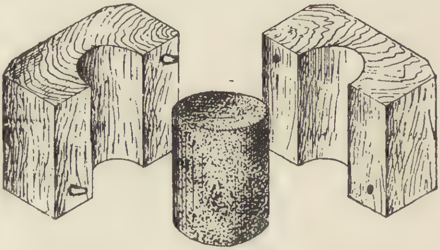


Fig. 63. CORE-BOX AND ROUND CORE.

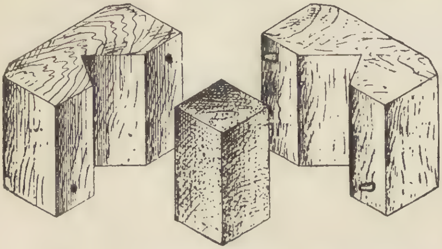


Fig. 64. CORE-BOX AND SQUARE CORE.

Cores may be of various forms, and an ingenious method of forming core-boxes of peculiar forms is given below. Turn a piece of hard wood just the shape for the hollow space within the casting, and also with the core prints on it. It is easier

to turn this into the shape wished than to carve out a similar shape in the two halves of a core-box. One form is shown in

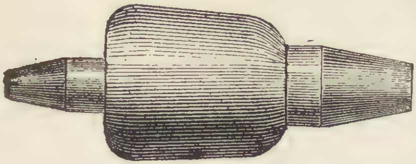


Fig. 65. MODEL FOR CORE-BOX.

Fig. 65, and to make a box from this, cover it with a thin coat of glue, and give it a coat of sharp sand or powdered glass, the same as that used on glass paper. One coat will not remain to do very great service, but is sufficient to grind out the two halves of the box after the greatest part has been roughed out with some tool.

As soon as each half has been ground nearly to the centre, place them both over the grinding form, and bring them close together, while the lathe is in motion, with a pair of hand clamps. The two halves of the core-box are clamped together just where they belong, with the grinding form between them. Now drill holes for the dowel pins, and square up the outside of the blocks true with each other. One of these core-boxes is shown at Fig. 66, all ready for filling with the core sand. In this way of grinding out a box, all careful paring out and filling in with wax is done away with, and

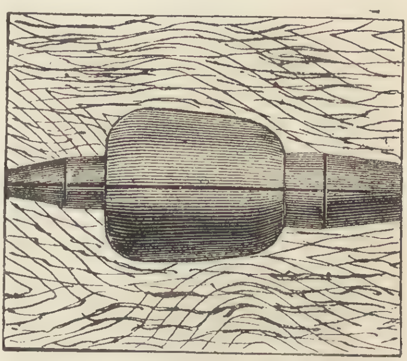


Fig. 66. CORE-BOX OF PECULIAR FORM.

a fit is got that is as near as need be, with very little trouble compared with cutting out by hand.

Probably in machine work no pattern comes round with

greater frequency than the pillow-block or plummer-block. Pillow-blocks are of various sizes, forms and kinds. They are made to be used plain, to receive a lining of Babbitt-metal, or for brasses. They are cast apart and bolted to framing are cast on the frames, and may form corner-blocks, brackets, standards and hangers; for all are modifications of the pillow-block. We may take it for an example in pattern making.

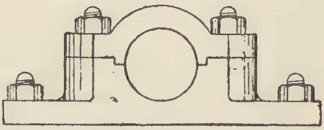


Fig. 67. Complete Pillow Block.

Fig. 68. Pillow Block in Plan.

Fig. 67 represents a pillow-block of the simplest kind, complete with its cap and bolts, as it would appear upon a drawing of some machine Fig. 68 shows the block in plan, the cap and bolts being removed. Leaving the cap for the present, we decide that that the block shall be moulded base uppermost, as in that position the whole of the pattern will lie in the lower part of the mould, the underside of the base presenting a level surface for an easy parting. The holding-down bolts require two oval holes to be made in the casting, round holes are also required, with square recesses, to receive the cap bolts. Fig. 69 shows the pattern with the necessary core-boxes for obtaining this casting.

Fig. 69. Pattern for Pillow Block.

For the base plane up a piece of board, giving it a little taper, or draft, to the ends, but leave the sides square until the other part of the pattern is attached. With a steel scriber, or cutting knife, draw a centre line across the base on both sides, lengthways of the base. The bottom of the pillow-block, which

is the side uppermost in Fig. 69, is the cope-side of the pattern. On the cope-side draw the recesses for the square-headed cap-bolts. On the reverse side draw the oval holes for the holding-down bolts.

The body of the block can be sawed at the band-saw. The sides of the block are supposed to be parallel, therefore very little draft can be given to them, say one-thirty-second of an inch for six inches in depth. Twice that amount may easily be given to the ends of the body, as at that part draft does not interfere. On the base of the block, in Fig. 69, are two projecting pieces having a great deal of taper. These are core-prints, which form recesses in the cope to steady the long cores which pass through the body of the block. The reason so much taper is given to these prints is because cores projecting into the cope, if not well tapered off, will catch on the sides of the recesses made for them in the cope, and damage or destroy the mould when it is being closed up.

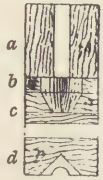


Fig. 70. CORE-BOX FOR CAP-BOLT HOLES.

These cope-prints should be fitted into recesses cut in the base of the block so that they may be loose on the pattern, if the block is to be moulded in a flask. Parts of a pattern that rise into the cope are preferred loose by the moulder, the objection against making them so is that pieces are liable to be lost when the pattern is stored away, an objection which should have but little weight under a proper system.

The core-box, Fig. 70, for the cap-bolt holes is formed of three pieces, exclusive of the ends. One piece, marked *a*, must be in length equal to the depth of the pillow-block, with the lower round prints : less the depth of the square recess in the base. In this piece plane out a semicircle of the diameter of the core. The piece next to it, marked *b*, is for the square

recess; it therefore corresponds with the heads of the bolts but is somewhat thicker and larger. In this piece a triangle is cut a little larger than half a bolt-head divided diagonally, as shown at *d*, the end view of the box. The piece marked *c* forms that portion of the core which fits the recesses in the cope left by the square tapering prints on the base of the block. It is therefore cut out to fit the half of these prints; the taper will then be the same. These pieces, fastened together, and having ends nailed on, form a box in which half a core can be made. The half cores, when dry, are pasted together.

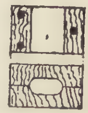


Fig. 71. Oval Core-Box.

The oval core-box, shown in Fig. 71, is formed by dowelling two pieces together, so that they part freely, and cutting out an oval whose centre line corresponds with the parting line of the box. The depth of the box equals the base of the pattern plus the oval print. The cap pattern, shown in Fig. 72, can be cut out with a saw; the two prints afterward to be bradded on to match those in the block. A special core-box is not necessary, as a portion of a core, made in box, Fig. 70, would serve. Moreover, most foundries are provided with boxes for making plain round cores of any size up to three inches or four inches. If thought more convenient, the cap may be made to mould the reverse way to that here shown.

Fig. 72. Pattern for Cap.

When a pillow-block is required with a Babbitt-metal lining, it is usually made as shown in Fig. 73. The patterns for the block and the cap are made as before described, with the exception that the place to receive the shaft, is cut out as much larger than the shaft as is needed to give the required thick-

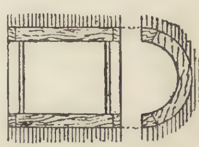


Fig. 73. Lined Pillow Block.

ness of Babbitt. A half-ring is then glued in each end of the hollow, to reduce the diameter to a little larger than the size of the shaft. Two slight strips of wood run the whole length of the bearing; they must be loose, and yet keep their position during the operation of moulding; therefore in each extremity of the half-rings a check is cut to receive the end of a strip. The strips must have a little play endwise, and also be planed a little narrower than the rings, or they will stand out beyond them in the casting. Plenty of taper should always be given to both strips and half-rings, as shown in the figure.

Fig. 74. PILLOW BLOCK TO MOULD BASE UPWARDS.

In small bearings—say under an inch in diameter—the strips, which are to keep the Babbitt lining from turning with the shaft, or from falling out, are sometimes omitted, in which case a recess may be cut in the pattern at the bottom of the bearing, or holes may be drilled in the casting.

In cases where a number of bearings of the same size are to be cast on a frame, it is often preferable to core them out, and so get a stronger pattern, with only one core-box to fit up with strips, etc., instead of all the bearings. Fig. 74 is an elevation of a different form of pillow-block pattern, intended to mould base uppermost, but to have the bearing cored out. In this block a print is fixed, where, in Fig. 69 the recess for the cap was cut out. This print is the same length as the bearing, but its thickness may vary. The drawing shows the pattern made for Babbitting. Sections of the required core-box are shown in Figs. 75 and 76. A block of rectangular section has a half circle cut out equal to the thickness of the print, plus the depth of the

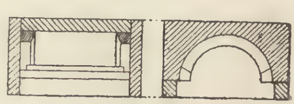


Fig. 75. Fig. 76.
SECTIONS OF CORE BOX.

the box, they need not be carried higher than the recess required in the casting. Half circle rings, equal to the size of the Babbitt outside, are placed at each end of underside of the strips, as these will be confined by the ends of the box. In some cases this makes a stronger and cheaper pattern, as one core-box will do for any number of bearings of the same size. The drawback is that which is common to all work when cores are employed. An element of uncertainty is introduced; the cores themselves may not perfectly agree together; they may be set untruly in the mould, they may be out of line or out of square.

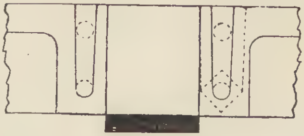


Fig. 77. Cored Pillow-Block.

Now take a pillow-block, which we are bound to mould sideways, because the frame on which it is to be cast moulds in that direction, and we have no choice but to core. Fig. 77 shows a block which will be wholly in the lower part or drag of the mould, the top being the line of parting.

The print as used in Fig. 77 is also applied in this case to ensure uprightness in the core. In addition to this a print cut to the form of the aperture required, is applied to the end of the bearing, forming an additional guide for the core. This is the method ordinarily followed, but if the exigencies of the work demand it, we may omit either one of these prints. If the print only is retained, make it much thicker, or the core may not be securely placed.

Fig. 78. Core-Box.

The core-box will be made as shown in plan, Fig. 78. In sections it resembles Figs. 75 and 76, but at one end it is longer as much as the thickness of the print.

The prints for the bolt-cores cannot be put on as before, as they would lock the pattern in the sand. The prints to be

employed will not only cover the outline of the holes, but will be carried up to the parting line of the mould as seen in Fig. 77. In this figure, the prints on both cheeks of the block are shown in full line, and also one of the prints on the base in dotted line. A core can be made that will fill the spaces left by the prints and have the holes in the castings in the core-box, shown in plan, Fig. 79. Fig. 80 being an end view of the same with one end of the box removed. The prints employed for the bolt-holes in this figure are called long prints; they should have plenty of taper,

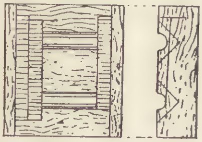


Fig. 79. Fig. 80.
CORE-BOX.

so that the core may be easily lowered into its place. Ordinary prints have very little taper, and the core-box is tapered to match.

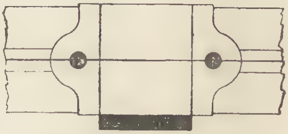


Fig. 81. PILLOW-BLOCK TO MOULD SIDEWAYS.

Another plan of making the pillow-block to mould sideways, though it cannot always be employed, is shown in Fig. 81. The pattern is made in halves, the parting line of the mould passing through the centres of the bolt-holes. The bearing prints and core-box are similar to Figs. 77 and 78, with the exception that the print is in two pieces. The bolt-hole core-prints are as in Fig. 69, but those on the base are not made taper.

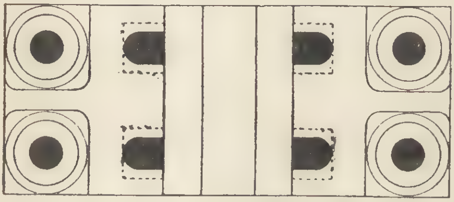


Fig. 82. PLAN OF PILLOW-BLOCK.

Another design for a pillow-block is shown in Figs. 82 to 84: a plan, an elevation and an end view. This pillow-block is for an eight-inch shaft. The base being three-and-

a-half inches thick, need not be made solid, but may be like a box without a lid — a piece of board the proper length and width, and one-and-a-quarter inches thick, with strips

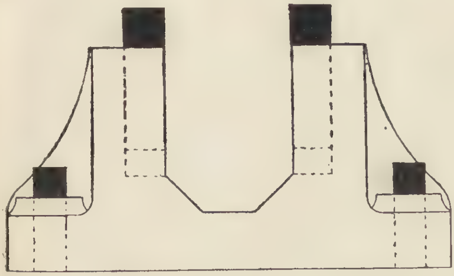


Fig. 83.
SIDE OF PILLOW-BLOCK.

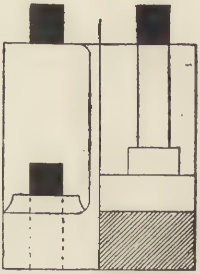


Fig. 84.
END OF PILLOW-BLOCK.

about one-and-a-half wide and two-and-a-quarter inch high, nailed on to make three-and-a-half inches around the edge of the board. Complete the base. The moulder will fill the box with sand when making his parting, so that the pattern will be just the same as if it had a base of solid wood.

Fig. 85.
CORE-BOX.

The cheek pieces being about twelve inches high, give them each not less than one-thirty-two inch taper inside, and three thirty-two inch outside, the edges to receive each one-sixteenth-of-an inch. These pieces should be set to a line, held in that position temporarily by fine nails partially driven, and then be very firmly screwed. The brackets, which strengthen the cheeks, may be screwed on next. The base of the brackets terminate in a small curve instead of a sharp point; this gives the cross-grain a better chance to stand; but we can get over the difficulty by cutting recesses in the brace for the brackets to stand in.

Nail and glue in the corner pieces, which form a seat for the brass; add the facings or bosses for the holding-down bolts, and nail prints upon them. The cap-bolts do not pass through the block, but stop at the corner pieces; this enables a bolt to be changed without disturbing the block from its foundation. The shape of the prints for the cap-bolts is shown clearly in the plan. They are to be fastened on top of the cheeks. The core-box for them is shown in plan and section Fig. 85.

Fig. 86. CAP FOR PILLOW-BLOCK.

Fig. 86 is an elevation of the cap; the black parts are prints.

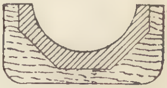


Fig. 87. SECTION OF BEARING.

Fig. 87 is a section of one of the brasses for this pillow-block; it will mould bearing uppermost, very little draft being given, as the brass-moulder's sand is finer, and therefore more tenacious, than that of the iron-moulder. Make first the body of the pattern, shaping the outer flat sides only. Fix a flange on each end of the body, and lastly saw the bearing out.

CHAPTER IX.

CIRCULAR WORK.

IT is often required to form circular patterns, short length, as compared with their diameter. When it is necessary that these should be strong, and preserve their shapes, are not made from a solid piece of wood, but are built up in layers and segments. For rings, or thick circular plate patterns, for preserving the size, and for strength, build up courses of segments, such as Fig. 88, the grain of each segment running at right angles to the radius, as shown in Fig. 89, the number of segments round the circle, may be for small rings, say from six inchs to eight inchs diameter, divide the circle into four parts. For larger diameters, up to four feet or five feet, use six or eight segments to the circle. The thickness of the ring to be built has to be considered in determining the number of segments, the fewer the segments the more cross-grain, and a thin ring will not bear so much as a thick one.

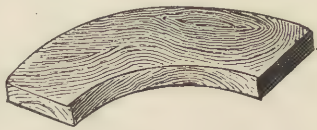


Fig. 88. A SEGMENT.

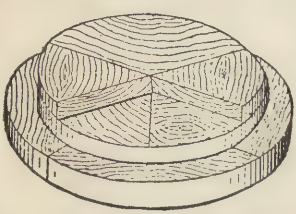


Fig. 89. BUILT CIRCULAR PLATE.

The greater the number of segments the nearer will the grain lie parallel with the circumference, and the truer the face plate will keep under changes of the atmosphere. It will

also turn up truer, because the tool is cutting with the grain all round circumference.

The thickness of the segments is to be considered. The thinner they are, the stronger the work. But with thick segments the work is built up quicker, and therefore cheaper—a matter often having considerable weight.

The construction of the wooden face-plate used in turning is a good illustration of this principle. Small wooden face-plates are generally made by simply screwing slabs of wood to the iron face-plate. As the diameter increases a batten is placed across the grain, which supports the face more uniformly, but does not avoid the shrinkage; when the diameter exceeds two feet a system of arms and segments is adopted as shown in Fig. 90. The direction of the grain in the arms tends to keep the outline of the diameter correct, while the grain in the segments keeps the circumference true.

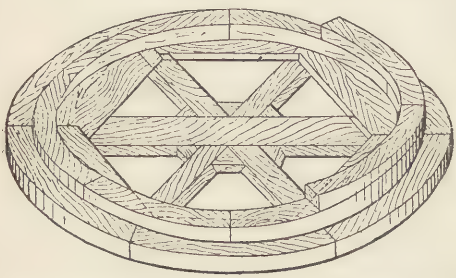


Fig. 90. RING BUILT WITH ARMS AND SEGMENTS.

In building up ordinary rings the same considerations apply, and the same course is taken in all built-up circular work. The cheapest and best method depends partly upon the tools and appliances of a shop.

Rapid building consists in the easy production of segments, and in laying them on quickly. To produce segments, the following is a good method :—

First lay out a template, allowing about three-sixteenths of an inch on each surface for turning, and not over one-eighth of an inch on the joint. The number of segments

should rarely be less than six to each course, the number being such as to afford sufficient lap over each joint for strength, and yet not too much crossing of the grain on the segment below. The thickness of the courses depend upon the strength required; as a rule the thinner the courses the stronger the ring, if the ring is thin, or narrow, it will require thin courses. Saw the pattern segment out carefully to the line. From this mark off on a board of the required thickness the number of segments requisite, and saw them out carefully to the line, as care in this point will pay in the building up and turning afterwards. In all segments, the grain of the wood must run at right angles to a radial line, drawn to the middle of the curve.

Our segments are now in condition to be laid on, without any further planing, either on the sides or ends. Having selected a wooden chuck the size, or a little larger, than the work to be built, strike a circle upon it exactly the same diameter as the segments are scribed to; unless this is attended to the segments will require jointing on the ends.

Remove the chuck with iron face-plate attached from the lathe and place it on the bench, supported by a ring or other packing to clear the face-plate, so that the chuck may lie firm and solid. Take the first segment, glue one end, set it to the line, and secure it by small nails partially driven in a slanting direction, into the inner and outer edges of the segment; it takes but little to hold it. Having glued each end of the second segment, set it to the line and butt it against the first; drive in a dog or square staple across the joint to draw it close and nail as before. So proceed until the fifth segment has been laid. Now take the last segment, which should be rather long, and fit it to its place. Place the work on the lathe and face off the first course.

The courses that follow are laid in the same manner, but

the nails will be driven through each segment. Each course should be faced on the lathe. After three courses have been laid, insert screws through the chuck fo hold the work, and withdraw the nails.

This method is most commonly practised for building up rings; but in some cases nails are objectionable. When this is so, having the chuck upon the bench, before laying the first course, place strips of paper where the joints will come, and others between, if the work is large. Glue each end of the first segment, and on the side which goes next the chuck put a few spots of glue. Set it to the line and cramp it down; serve the next in a similar manner, dogging the joint before the cramps are applied. When a course is complete, it must have time to dry, perhaps an hour or more. This is inconvenient, unless you have some other work while this process is proceeding, or the insertion of wooden pegs be permitted. In such a case the cramp may be removed, and the work faced off immediately in the lathe.

Another method is to bore holes through the face-plate, a sliding fit for screws, one or two to each segment, according to size. Place the first segment to the line and screw it on from the back, with the truest side to the face-plate. Next place the second segment with its sawn joint butt against the sawn joint of the first, set to the line and hold with hand screws. Now saw through the joint, then tap up the second segment to close the joint, and screw fast to the face-plate. This is repeated with the rest of the segments of the first course. Take off every alternate segment and glue the butt joints, first putting thin paper under each joint so that it will not be glued to the face-plate. Face off the first course on the lathe; by testing the face with a chalked straight edge it can be made very true. Then, while still in the lathe, commence with the the next course by gluing on the first segment across a joint,

and either carefully nailing it down in the centre with four nails or with pins, or by pinning it down on the outside edge by toe-nailing, or, what will be found the best in light work, is to dog the joint together with staples. Each segment is held by one or two hand screws while the saw is being run through the joint, and then taken off and the next one put on, and so on. By this method the building up may be done

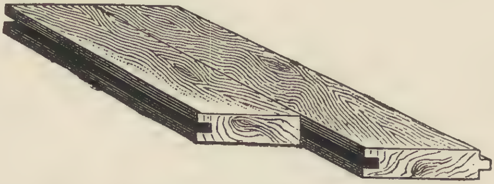


Fig. 91. SERIES OF TONGUES AND GROOVES.

entirely in the lathe by a continuous gluing up, not having to wait for the glue to set, or to face up segments, and with the use of but two hand screws, while the joints are made easier and better.

To produce a circular disc that will retain its size and shape, build a strong rim with two courses of segments glued and screwed together, and turned out in the lathe to form a rabbet. Then turn a panel, to fill the centre, and fix it in place with screws. The centre filling, if large, should be composed of several strips with their edges grooved to receive a tongue, which runs the whole length of the joint. See fig. 91. When several boards are to be joined edgeways, the tongues and grooves are made as shown in fig. 92. The joints should be left a little open.

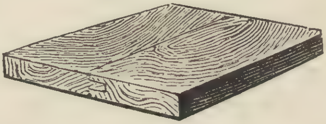


Fig. 92. GROOVE AND TONGUE JOINT.

If the required disc is too thin to admit of the above method

of treatment, the following stands very well, but is liable to become "dished," that is, hollow on one side and round on the other. Prepare a series of rings, each composed of one course of segments, and turn a centre-filling, composed of quadrants. Take the segments composing the smallest ring and glue them, one by one, by their inner edge to the centre. Glue on the other rings in segments in the same manner until large enough. A disc four feet in diameter should have the centre about twelve inches diameter and the segment rings about four inches wide. These sizes might lessen for a smaller disc, but not increase much for a larger. Thin wide rings are also made in this manner by leaving out the quadrants. It sometimes occurs that a loose circular flange or pattern is so thin that but one thickness or course can be easily made; then the neatest way to strengthen the joints of the segments is to make a saw cut in the centre of the ends of each segment, and when gluing up to insert a thin piece of hard wood fitting the saw cut nicely, the grain of the tongue being at right angles to the joint.

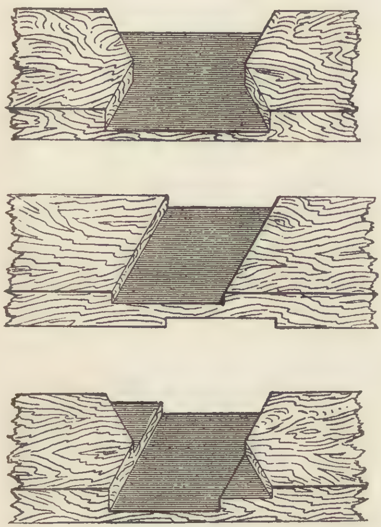
For a wide ring, say one inch or upwards, of sufficient thickness to admit of screws or nails being used, the following method suits for good stock patterns: Carefully lay down an accurate, full-size plan of half the ring, below it draw the ring in section. Mark the width of the inner and outer rings, which are built with two courses of segments in each. Divide the space into any number of equal parts, so as to have about four inches between the divisions on the larger circle, and draw radial lines, as in the figure. The spaces thus formed will represent the pieces of which the annular panel is to be composed. Cut out a template to this form, and trace from it on a board of the proper thickness. As the pieces are to finish to the size of the drawing, they must be sawed out a little longer to allow for turning.

Arrange the panel pieces radially on a face-plate and temporarily fasten by nails, then turn down the inner and outer edges to form rabbets. Number the pieces and detach them. Build the two marginal rings, and take any one of the panel pieces and turn out the space between the rings to fit it. The panel pieces need not be glued together, nor is it necessary to plane the joints, as space must be allowed for swelling when brought into contact with the damp sand of the foundry.

In constructing the pattern for a cylinder of eight inch bore or under, it is best built up in quarters; and when larger, it should be built up by lagging. In gluing up the quarterings turn the heart side of the wood outwards, and leave it long enough to turn up the prints solid with the drum. The flanges are separate and have the grain running in the opposite way. They are let into a turned groove about a quarter-of-an-inch deep, then screwed fast from the inside of the parting, and turned up with the body of cylinder.

In lagging up the pattern for a cylinder, the length of the drum would be from inside of flange. The head and print would be made separate, and screwed on from the inside. By this means a smoother surface is got on the head end to draw from the sand than if the end of lags came through. Flanges of the larger size should be built up in segments of two layers, with the grain crossing. The bearings should be near enough together so avoid any spring in the lags, while a rib is set between them to brace the drum endways. The lags are jointed, glued and screwed, the heads of screws being let in sufficiently to allow wooden plugs to be glued into the countersink. The grain should be the same way as the lags. The two halves are jointed together, and the holes for dowel pins are bored through the one half into the other while they are clamped together in position. The further apart the more serviceable dowel pins become, always provided the necessary strength

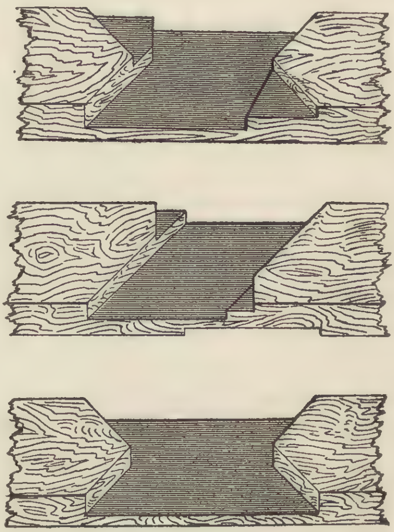
to hold the dowel firmly. A centre plate is screwed on each end, these are made to fit the lathe, one end having a counter-sunk centre, while the other is made to fit the lathe chuck. These plates have centre lines carefully marked upon them, these lines being set to the centre lines of pattern. When the cylinder is too small to use these plates the wood is left three inches longer at each end, where a counter-sunk screw holds the halves together. The steam chest is first planed to the shape and size of body, glued up solid with its print then fitted to cylinder and screwed on from the inside. Side draft of about one-eighth of an inch to the foot should be allowed on all square surfaces. Dowel pins are put through the steam chest portion the same as in the cylinder. These pins should be rounded over to work free, fitting the hole for about one eigth of an inch. When there is much wear expected on them, iron dowel plates let in level with the joint are used.



Figs. 93, 94, 95.
THREE-PART CHECK JOINT.

Arms for wheels are generally made from pieces of wood twice the length from the centre to the rim, and the thickness of the arm at the centre. If there are six arms, three lengths are required. They are let one into another at their centres as they cross each other, forming six equal angles, by dividing the

thickness into three equal parts. The three-part check, used for wheels that have six arms, and other purposes, is illustrated in Figs. 93 to 95; by this method three pieces may be joined together in the thickness of one. Find the centre in each of the three pieces; then, with a radius equal to half the width of a piece, describe a circle on one side of the top and bottom pieces, and on both sides of the middle piece. Set a bevel to 60°, and with it draw lines touching the circles, as shown in the figures. By gauge lines divide the thickness of the pieces into three equal parts. Cut away all the portions of the pieces as shown. The middle piece, Fig. 94, is to be cut in on both sides, as drawn in the figure, leaving one third part in the centre. The top piece, Fig. 93, must have the part represented by the cross shading cut away for a depth of two-thirds of the thickness.



Figs. 96, 97, 98.
Four-Part Check Joint.

The four-part check is used for similar purposes when eight arms are wanted; Figs. 96 and 97 convey an idea of the manner of making this joint. As before, describe circles on one side of Fig. 96 and Fig. 98, and on both sides of Fig. 97. Set a bevel to 45°, and draw lines touching the circles. Three-quarters of the thickness of Fig. 96 must be cut away as repre-

sented in the figure. The two middle pieces are exactly alike on one side. The part cross-shaded must be cut down in two parts, or half the thickness; the little corners for a depth of one part only. The other side is to be cut away one part. The cross-shaded part in Fig. 97 is cut down three parts, and the corners lightly shaded one part.

Another and a stronger method for large centres is to get out the wood in six pieces the length of radii, and make a joint in the centre butting them together with glue. When dry take the two metal plates with holes drilled in the centre of each, suitable for hub pins, set the hole in the centre of the joints, and let a plate into the arm level on each side. Set a hard wood plug in the centre, and strike off the length of each arm. On this circumferential line space off centres for the arms, scribe the centre lines of the arms, from which produce the outline, which is next cut out. See that one face of each arm is true and straight, from this gauge the necessary taper of the arms on the end and [plane down to it, and dress the edges of the arms to the shape required.

The rim, arms and hub of a wheel must be so proportioned that they will shrink alike, and in the same time, and contain the strength required to perform the work. If the rim is light and the arms heavy, the rim will shrink more than the arms, which will be likely to crack the rim, while if the arms are light and the rim heavy, the arms will crack. When the hub is heavy, in proportion to the arms and rim, it will remain hot longer, and continue to shrink after the rest is set, thus creating a strain, drawing the arms from the rim, which is sometimes sufficient to so weaken the arms that a slight tap with a hammer in addition to the strain, will break them. To overcome these strains the hub is sometimes bared and the core drawn, so as to cool it off quicker. To avoid these internal strains in a pulley casting, various devices are adopted, which may give an

idea of how to overcome strains in other castings, we have the curved arm, also the arm set at angle to the radius. Both these devices act on the principle of drawing the hub round as it cools, and thus, to a great extent, relieving itself of the strain.

CHAPTER X.

MISCELLANEOUS WORK.

THE preceding examples having been somewhat fully described, more brief particulars of some examples of Miscellaneous Work will be given. A Pattern maker must be able to adapt his knowledge to the requirements of the work he has in hand, and for this reason any attempt at minute description of general work would be futile.

Wooden pegs used in place of nails in patterns are made by sawing off blocks the required length of the pegs, and cutting them with a chisel into pieces about one-eighth of an inch square; making them in this manner ensures their being straight in the grain; those not well formed must be rejected. Pare points on the pegs and let round holes to receive them be bored of the same size as the pegs are square. The same kind of wood used in the pattern serves also for the pegs.

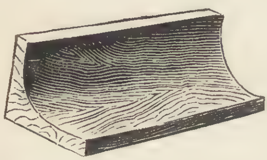


Fig. 99. WOOD ANGLING.

The internal angles of every corner must be filled up to guard against the casting becoming unsound through the cooling of the metal, as explained in Chapter II.

Strips of wood, shaped like Fig. 99, are commonly used for filling in the angle. Special angling is made and sold for the purpose, and this is often cheaper than planing strips of wood when the angle is considerably curved or made up of short pieces.

Fig. 100, shows the application of Tangye's foundry pattern angling. This angling is fixed by cement, and the makers assert that three times as much straight work and ten times as much curved work can be done by using this material instead of moulding the angle out of the solid.

The method of joining two pieces of wood together by halving is apparent upon looking at Fig. 101. Call one side of each of the pieces to be joined in this manner, the face, and make a mark with a pencil to indicate the face side. Set a

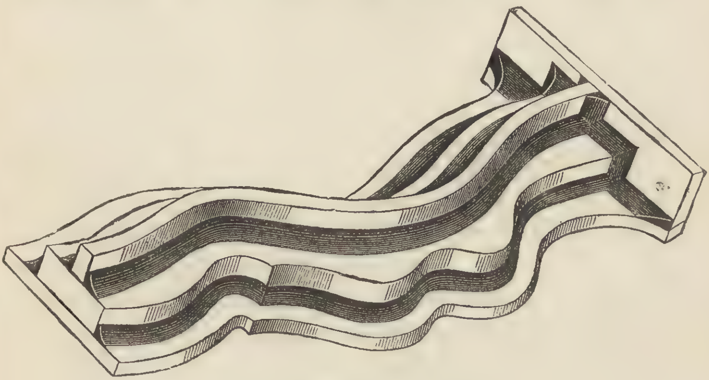


Fig. 100. COMPOSITION ANGLING.

gauge to half the thickness of the stuff. Gauge lines on the edges where the pieces are to be joined, and saw down to the gauge line. Always gauge from the face side, then if the gauge was not set exactly to half the thickness, the joint will still come even. Screw the pieces together, then take them apart and put on glue, screwing together while the glue is hot.

Corner half-checks are generally cut the whole width of the stuff, as in Fig. 102, but middle pieces are sometimes checked short, so as to leave a portion of the timber the full thickness, adding thereby to the strength of the frame, as in Fig. 103.

The dove-tail half-check is shown in Figs. 104 and 105, it is

used, not so much to hold the pieces together, as the glue and screws would be sufficient for that, as to enable a portion of the frame to be hollowed out, and yet not reduce the cross-grained parts where the pieces butt together so much as to make them weak and brittle. The same purpose may be served by using the ordinary half-check, provided the tongue and space it fits be made narrower than the stuff is wide. The illustrations make the construction clear.

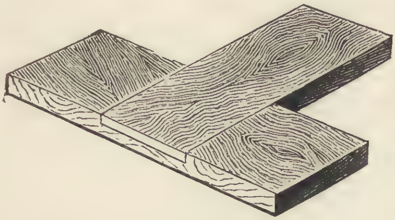


Fig. 101. Joint made by Halving.

The half-check joint being only available for pieces of rectangular section, a sort of butt joint is employed for pieces that are curved or irregular, in section. A frame may be put together by mitring in the methods shown by Figs. 106 and 107. It will be seen that the joint line always bisects the angle formed by two meeting sides of the frame. This bisection of the angle is the principle of mitring.

Mitre joints seem very simple to make, and if the work does not need to be very exact, are not difficult; but if the frame is required to be perfectly square, and to size, it requires care to get all the joints close and even.

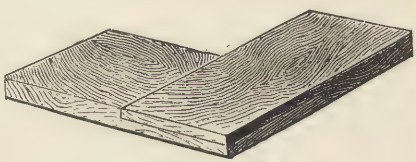


Fig. 102. Corner Half Check.

The ordinary appliances for cutting mitres are shown in Figs. 13 and 14, these are a mitre-box for sawing the mitres, and a mitre-board for planing them. The box consists of three planed pieces of wood, fastened together to form a kind of

trough, in the sides of which two saw-cuts are made to the correct angle. These cuts act as guides for the saw in cutting the stuff placed in the box. The mitre-board is made as described on page 37. The plane is either thrust from the workman or reversed and pulled towards him, depending on the direction of the mitre.

Pieces that are curved in the direction of their length, are butted together, so that the line of the joint must lie in the direction of radii to the curves, as shown in Fig. 88.

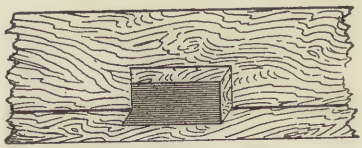
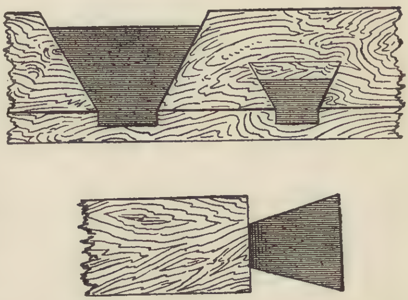


Fig. 103. HALF-CHECK.

Joints of the above description may be much strengthened if, after the glue is dry, one or more saw-cuts are made across the joint, thin wood being afterwards fitted and glued in; the grain of the filling-in piece to lie across the direction of the joint.



Figs. 104, 105, DOVE-TAIL CHECK JOINT.

For the pattern of a small pinion under six-inch or eight-inch diameter, a solid block of pine or poplar is generally used. It must be dry and straight-grained, the teeth being formed lengthways of the grain. For gears of fine pitch, and with arms, mahogany or cherry wood is generally used, but sometimes for the teeth only, the rest being of pine. For large gears pine is used, sometimes substituting poplar for teeth. To make a pinion from a solid block, it is first screwed on a face-plate which is smaller than the diameter at the bottom of the spaces,

so that when the block is turned to the size of the outside of the teeth, allowing about one-sixteenth of an inch taper per foot for draft, circular lines can be traced on both ends indicating the pitch-line, the line for the roots of the teeth, and also lines for the centres used in forming the flanks of the teeth. Some pattern makers think it well not to give any taper to the teeth, but if the moulder be not helped, he will help himself to draft by extra rapping. It is safer to give draft; besides the lower part of the mould will always run larger or fuller than the upper, and this will largely make up for the draft that is needed. When there is not a face-plate small enough to clear the teeth, bore a hole in the block, and turn it upon an arbor of hard work. For solid pinions larger than six inches or eight inches diameter the body should be built up in segments as shown on page 107, and the teeth planted on separately with dovetails.

Fig. 106. MITRE JOINT, FLATWAYS.

In all larger gears where arms or a plate are used it is generally cheaper, more accurate, and stronger to construct and turn the rim separate from the arms or plate. In a plate-wheel, if built with the segments glued upon one or both sides, the shrinkage strains would tend to contract or expand the rim across its grain. It is better to build the rim separate with the hollow and a portion of the plate formed on the inside in which a separate piece for the plate will be fitted with a ledge, and glued, so forming the centre. To build the arm up into the rim, where the rim is very light, as in the case of

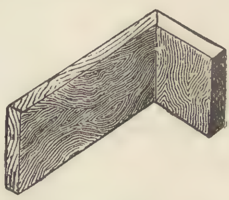


Fig. 107. MITRE JOINT, EDGWAYS.

gears, tends to weaken the rim-pattern at these points, and it is also difficult to finish the rib or bead which generally runs on the inside of the rim. Turn up the inside of the rim to a template, giving ample draft so that the sand will easily lift up with the cope. About three-eighths of an inch or half an inch to the foot taper is sufficient. Let in the arms carefully in the centre, glue, and screw from the outside. Turn off the outside of the rim, allowing a slight draft of about one-sixteenth of an inch to the foot of its face, and mark upon it a fine line upon which to space off the face for the teeth, and also one line on each edge showing the depth of dove-tails.

In spacing off, when the number of spaces required is divisible without remainder, it is better to lay off the larger divisions first. For instance, for sixty teeth divide the circumference into six parts, then sub-divide each by two, then by five; or by ten, instead of two and five. If fifty-nine teeth, lay off the radius chord, and space nine and five-sixths parts; or if sixty-one teeth, into ten one-sixths, and so on, the fraction being the guide as to how you will come out on the whole circle. This will save spacing the whole wheel round for each trial, and be more perfect, because of the fewer points made in spacing. Be careful to have the compass points fine and sharp, and the legs firm.

CHAPTER XI.

A GLOSSARY OF TERMS USED IN MOULDING AND FOUNDING.

Air or foul air.—The gases generated in casting, and driven through the sand.

Air-drain.—A passage to conduct gasses from moulds deeply bedded in the floor of the moulding-shop.

Air-gate.—An opening at which displaced air escapes during pouring, and in which metal afterwards rises.

Air-hole.—A hole or cavity in a casting produced by bubbles of air in the liquid metal. Also a vent-hole made in a mould to allow air to escape.

Barm.—Yeast used in the preparation of core-sand to render it adhesive.

Bellows.—Used to blow loose sand or dirt out of the moulds, or parting-sand from the pattern.

Blackening.—Charcoal-dust applied to a mould to give smoothness to a casting, and also to dust the partings of a mould.

Black-lead.—Sometimes used for blacking moulds or for mixing with sand.

Black-wash.—A solution of clay and powdered charcoal applied to the surface of sand-moulds, to give a clean skin to the casting; also used as a parting.

Blow.—The forcing of displaced air through the molten metal from insufficient vent.

Blown.—The condition of a casting containing cavities caused by enclosed air.

Bot.—A pear-shaped piece of stiff clay used to stop the flow of metal from the tap-hole of the furnace.

Bot-Stick.—An iron rod provided with a long wooden handle at one end, and a small round disc at the other, to receive the clay, used for botting off when the ladle is sufficiently full.

Box.—A very common term, being a contraction of moulding-box, and signifying flask.

Brick.—Used largely in loam-moulding.

Burned sand.—Sand, the tenacity of whose clayey portion has been destroyed by the heat of the metal.

Burning together.—Union produced by flowing hot metal in quantity over cold.

Burning-on.—A process of mending castings by uniting fractured portions, or by attaching a new piece. The casting is fitted in a mould, so arranged as to allow a stream of molten metal to flow through and around the parts to which a piece is to be attached. When the casting has become sufficiently hot, the flow is stopped, and the mould allowed to fill. The new metal is thus burned on to the old.

Case.—A cope.

Cast-gate.—The ingate at which the metal is poured in.

Casting-box.—The flask containing the mould.

Casting-ladle.—An iron vessel usually lined with fire-clay, with handles for conveying molten metal from the cupola and pouring it into the mould.

Chamber.—The portions of the mould which contain the exterior form, and which are closed around the core in casting hollow ware.

Chaplet.—A wrought-iron stud to hold a core in position in a mould. A grain or staple.

Charcoal.—Used in dust, as dry blackening, or in suspension with clay, as black-wash (which see).

Cheek.—The middle part of a three-part flask.

Chill.—A piece of iron in a mould to suddenly cool the metal flowing against it and render it hard. Cast iron is hardened by rapid cooling, and by means of a chill it may be rendered as hard as hardened steel.

Chipping-piece.—The projecting portion of a casting which is intended to be chipped and filed or planed flat, so as to have some other part of the work fitted to it.

Clay.—All clays are essentially hydrous silicates of alumina, more or less mingled with mineral impurities, and coloured by the presence of metallic oxides and organic matter. Pure clay (silicate of alumina), is refractory—that is, capable of resisting intense heat. In the common acceptation of the term, clay is an earth which possesses sufficient ductility and cohesion, when kneaded with water, to form a paste capable of being fashioned by the hand. The majority of clays are superficial deposits occurring in estuaries, dessicated lake-sites, river valleys and upraised sea-beds, or scattered over the surface as drifts or boulder-clays.

Clay-wash.—Clay in solution for smearing the insides of moulds and gaggers to make the sand stick; for cementing the portions of cores; for strengthening loam and adding to charcoal to make black-wash.

Cleaner.—A tool of thin steel or brass, from six to eighteen inches in length. One extremity has a bent spatula blade; the other, a short blade bent on the flat to a right angle. Used for smoothing the moulded surfaces and removing loose sand. Also called a sleeker.

Coal-dust.—Powdered coal added in certain quantities to green sand, according to the quality of the latter.

Coke-dust.—The same in effect as coal-dust.

Compression-casting.—A mode of casting under pressure, which causes the metal to flow into the more delicate

lines, etc., of a mould. The moulds are made in potters' clay, and the casting approaches the work of the graver and chisel.

Contraction-rule.—A rule, divided in excess of standard measurement, used by pattern-makers, and thus avoiding calculations for shrinkage.

Cope.—That part of the flask which is uppermost at the time of casting. The upper box or top part. The outside portion of the mould in loam work. Also called the case. The lower part of the flask is called the drag, or nowel.

Core.—A mass of sand, moulded and baked, and placed in a mould to form a cavity in a casting.

Core-bar.—An iron bar to stiffen a core.

Core-barrel.—A perforated iron tube to form a passage-way for the gases passing off through the interior of a core.

Core-box.—A mould in which a core is formed.

Core-pipe.—A core-barrel.

Core-print.—A projecting piece on a pattern which produces a cavity in the mould, in which a portion of a core rests and supports the core in place.

Core-sand.—Coarse new sand with powdered loam.

Cotter.—A key which locks the steady-pin of a flask.

Cow-hair.—Used as a bond to increase the tenacity of loam.

Crane.—The hoisting apparatus of a foundry to move heavy flasks, castings, &c.

Crucible.—A melting pot of an earthen composition, or of refractory metal, adapted to withstand high temperatures.

Cutting-out.—A process of removing some of the sand in a mould so as to enlarge it for the casting to be larger than, and perhaps somewhat different in form, from the pattern.

Dead-head.—That piece on a casting which fills the ingate. A feeding-head or sullage piece.

Delivery.—The draft or taper by which a pattern is made

to free itself from close lateral contact with the sand of the mould as it is lifted. Also called draft, taper, draw, &c. A pattern is said to deliver well when it leaves the sand without breaking down the mould.

Drag.—The lower box or bottom part of the flask. Also called the nowel.

Draw.—The taper of a pattern which enables it to leave the sand without impairing the mould. Also called delivery, draft, taper, &c. To lift the pattern from the sand.

Drawback.—The ironfounders' term for what brass-founders call a false-core.

Drop.—The fall of sand from the top part into the mould.

Dry-casting.—The process in which the sand-moulds are dried before use. (See "Dry-sand.")

Dry-sand.—A mixture of sand and loam which is employed in that description of moulding done with loam and sand in due proportion, the mould being oven-dried before casting.

Drying-stove.—A heated room for drying dry-sand moulds or cores.

Facing.—Powder applied to the face of a mould, with the object of giving a fine smooth surface to the casting. Facing consists of various materials, amongst which are the following: Meal-dust or waste-flour, powdered chalk, ashes of wood or tan, charcoal-dust, loamstone powder, rottenstone powder. An equivalent effect is produced by depositing a layer of soot produced by smoking the pattern over a fire of cork shavings —or of burning resin.

Face-dust.—Powdered charcoal for iron castings, mill-dust or pease-meal for brass. It is dusted from a bag over the mould to improve the surface of the casting. Powdered soap-stone, rottenstone, graphite, or chalk is sometimes used.

Facing Sand.—New sand used in immediate contact with

the pattern, being sifted thereon and then backed up with old sand and rammed.

False-core.—A mass of moulded green-sand placed against the side of a pattern which is undercut. Before drawing the pattern, the false-cores are removed, and are restored before closing the flask. Also called a drawback by iron-moulders.

False-part.—A flask temporarily filled with sand in which the pattern is sunk to a parting-line before ramming up the other side of the box which is to form the drag. After turning over, the false part is broken up and the parting properly made.

Feed-head.—The metal above and exterior to the mould which flows into the latter as the casting contracts on cooling, thus serving to render the casting more solid. It is also called a dead-head, head, and riser. The metal forming the feed-head is called a sullage-piece.

Feeding-rod.—An iron rod for keeping open the head or riser at which hot metal is added from time to time as the casting contracts in cooling.

Fettle.—To clean castings, removes gits, fins and cores.

Fin.—A thin ridge of metal extending along the parting-line of a casting where the metal has insinuated itself between the parts of the mould.

Flask.—The box or frame which contains the rammed sand forming the mould. If the mould is contained in two sides they constitute a two-part flask. The upper part is the cope; the lower the drag.

Flask-clamp.—A contrivance for binding together the parts of a flask.

Flow-gate.—An opening from the mould to the surface; in it the metal rises as it is poured into the cast-gate and fills the mould.

Follow-board.—A board used under the flask to support the sand when ramming.

Founder's-lathe.—A spindle running in notches on trestles, and used with a loam-board for preparing long cores, etc.

Furnace.—Used for melting the metal. There are three distinct classes of furnaces, viz., cupola, crucible or pot furnaces, and reverberatory.

Gaggers.—Pieces of metal used to hold together large quantities of sand in moulds. A common form of gagger is a double hook hung to the crossbars of the top part of a flask, and entering the sand which fills the deep part of a pattern, to enable the sand to be lifted out.

Ganister.—A highly refractory material used for lining furnaces and for other purposes. Sheffield ganister contains about eighty-five per cent. of silica combined with about equal proportions of magnesia and alumina.

Gate.—The opening through a mould into which metal is poured. Gates include all the passages which lead the fluid metal into the mould. The large opening into which the metal is first poured is the pouring-gate, next is the skimming-gate, and then the sprue gates. The feeding-gates supply metal to the casting as it contracts in cooling. The metal flows from the ingate through the runner into the hollow in the mould, where it forms the casting. The metal which occupies the gate forms a head.

Gate-channel.—The opening through which the metal flows to the mould. (See "Gate.")

Gate-shutter.—A tool, such as a spade, used to close a channel against the molten metal when the mould is full, and also sometimes used to turn the stream into some other channel.

Gland.—A bent rod of iron forming a double hook to lock the parts of a flask together.

Grain.—A piece of short metal or cast iron inserted into a

mould for the purpose of supporting an accessory portion, such as a core, in position. A Chaplet.

Green-sand.—The damp sand of the foundry prepared for moulding. (See "Sand.")

Grunter.—An iron rod used in supporting the crucible when pouring.

Hay-rope.—A twisted hay-band wound about a core-barrel in making large cores.

Head.—A flow-gate or riser over the largest part of a heavy casting, in which the hot metal rises, and into which metal is poured from time to time as the metal contracts. This head, also called spreel and sullage-piece, is knocked off the casting.

Horse-dung.—Introduced into loam, as hair into plaster, to form a bond in dry-sand moulds.

Ingate.—The opening through which metal is poured into the mould. It then passes along runners to the spaces made vacant by the withdrawal of the patterns. Also called tedge, gate, geat or git, the latter two being corruptions of gate.

Ingot.—A mass of metal as run from the smelting furnace, particularly applied to gold, silver, steel, etc. Ingots of iron and copper are called pigs.

Ladle.—An iron vessel, coated with loam, and used to convey molten metal from the furnace and pour it into the mould. One form is a shank.

Lantern.—A perforated core-barrel, of large diameter relatively to its length.

Lift.—The separation of the cope from the drag.

Lingot.—An iron mould for casting metals.

Loam.—A mixture used in moulding which essentially consists of sand and clay, the former largely predominating, with a certain quantity of horse-dung added, or some equivalent for it, such as chopped straw, sawdust, cow-hair, etc. Beds of

loam are sometimes found of nearly suitable composition, but it is more commonly made by blending the various materials in a pug-mill. In moulding it is always used quite wet, like plaster, but is dried thoroughly before pouring. Its characteristics must be plasticity while wet, strength and solidity when dry, perviousness to the air from the mould, and power to resist the high temperature of the molten metal.

Loam-beater.—A rammer used to make the sand and loam around a pattern compact.

Loam-board.—A board resting on trestles, and holding the loam used in making cores. The board is shaped to a counterpart of the form that it is desired to make the core, and is used as a turning tool. The wet loam is supplied to the core-barrel from the board, and some adheres, all superfluous being scraped off by the action of the board.

Loam-cake.—A disc of loam, used as a cover on a loam-work mould, perforated with holes for the metal to be poured through and for the escape of air.

Loam-moulding.—The process of making moulds in plastic loam by means of templates.

Loam-plate.—A flat cast-iron ring or plate, on which the nowel and cope rest in loam-work.

Loam-work.—The method of making moulds for large hollow castings in which the nowel and cope are separately built up of bricks, &c., and covered with plastic loam, which is shaped with a template. The two parts, after being dried, are brought into position and packed with sand before the metal is run.

Loosening-bar.—A stiff rod extending upward from the pattern, through the sand, and which is struck from opposite sides to loosen the pattern in the mould before lifting the top-part. This operation facilitates the separation of the sand from the pattern, and so lessens the liability to break down the mould.

Mantle.—A covering of clay destined to be used as a mould.

Match-plate.—A plate having upon its opposite sides the halves of a pattern placed to correspond. The operation of moulding is thus greatly facilitated. The match-plate is placed between the parts of a flask and rammed from both sides; on removing the plate the parting is complete, and the use of an odd side dispensed with.

Metal.—The founder's term for cast-iron.

Mould.—The matrix in which an object is cast.

Mould-facing.—A fine powder sprinkled over the pattern before the facing-sand is sifted into the flask, with the object of making a smoother surface to the mould.

Moulder's Clamp.—A frame by which the parts of a flask are held together ready for pouring the metal.

Moulder's Table.—A bench at which the workman stands when moulding small objects.

Moulding-board.—A board on which the flask rests while the sand is being rammed.

Moulding-hole.—The pit in the floor of a foundry in which large castings are made.

Moulding-loam.—The mixture of sand and clay used in loam-moulding.

New-sand.—Facing-sand next to the pattern.

Nowel.—The inner portion of the mould used for casting large hollow articles; it answers the purpose of a core in small work. Also the lower part of a flask.

Odd-side.—A permanent false-part. When many castings are required from the patterns moulded in one flask, the false part is prepared in an odd-side, and this is carefully preserved indefinitely. Thus, much time is saved in making the parting.

Old-sand.—The sand of the foundry floor, killed (that is,

made weak and friable) by use, and not fit for facing, but well suited for filling the flasks over the facing sand.

Open-sand Moulding.—A mode in which moulds are made in the floor of the foundry without any cope, and usually filled direct from the furnace.

Part.—One portion of a flask, as the top part, which is the cope; the bottom part, which is the drag or nowel; the middle part containing the middle portion of a three-part flask, &c.

Parting. — The line of separation between the sand rammed in the respective boxes or parts of a flask. A powder is applied to these surfaces to enable them to separate readily.

Parting-line.—The line upon a pattern below which it is imbedded in the drag, and above which it is in the cope or top part.

Parting-sand.—Sand free from clay, which is scattered over a green-sand surface where a parting is to be made.

Pattern.—The counterpart of a casting in wood or metal from which the mould in the sand is made. Patterns are sometimes made in two or more parts, held together by steady-pins or dowels. Straight-grained pine or mahogany is preferable wood for patterns. They are made somewhat tapering, in those parts which have to be deeply imbedded in the sand, so as to facilitate their withdrawal. This taper, technically called draw, may be from one-sixteenth of an inch to three-sixteenths of an inch to the foot. Patterns are sometimes made of metal, especially for small castings, as they are more durable; but if made of iron, require care to prevent rusting. Wood patterns should be well oiled and varnished to preserve them and to assist their delivery from the sand; a coating of black-lead is also very conducive to this. Sharp angles should be avoided as weakening to the casting and tending to cause a breakdown in the mould.

Pease-meal.—Dusted on as facing for moulds in brass

casting; also used in iron casting as a medium for holding blockings.

Perier.—An iron rod used for holding back the scum on the metal being poured.

Picker.—A steel rod with a sharp point, used in picking out small patterns from the sand.

Pickle.—Dilute sulphuric acid used in cleaning castings. It attacks the surface of metal and removes the sand and surface impurities. This treatment improves the appearance of the work, and when the surfaces have to be made smooth by filing, &c., it saves much of this labour.

Piercer.—A vent-wire.

Pig.—An oblong mass of metal as run from the smelting furnace. A main channel, called the sow, is made in the sand, along which the metal flows from the tapping hole of the furnace. On each side of the sow small hollows are made, into which the metal flows and solidifies, forming pigs. Iron and copper are cast into pigs; gold, silver and steel into ingots.

Pot.—A crucible, generally of graphite.

Print.—A projection on a pattern which leaves a space in the sand for supporting a core in position.

Rammer.—An implement for compacting the loam around the pattern in the flask.

Rapping.—Loosening the pattern in the mould.

Red brick-dust.—Sometimes used as a parting-sand.

Riddle.—A coarse sieve, about half-an-inch in the mesh, used to mix sand on the floor of the foundry.

Riser.—An opening though a mould into which the metal rises as the mould fills, and through which more metal is poured in as the mass contracts.

Run.—Said of a mould if the metal insinuates itself along the parting, or otherwise leaks out.

Runner.—A channel leading from the gate to the space left by the removal of the pattern from the mould.

Runner-stick.—A pattern for forming the gate of a mould.

Run-through.—When metal is poured in at one gate and runs out at another. By this means sullage, air, &c., are removed and a solid casting obtained. A process sometimes adopted in casting a piece solid to another piece already in the mould.

Sand.—Crystalline particles of silica mixed with clay, which confers tenacity. Used as a material for ramming around patterns in moulding. Sand useful to the moulder must have tenacity when damp and retain it when dry, and be pervious to air. In these respects various kinds of sands differ greatly, and mixtures are generally made to suit the particular want. For ironfounding powdered coke and coal are sometimes added. Sands for different purposes have specific names, as core-sand, dry-sand, facing-sand, green-sand, new-sand, old-sand, strong-sand, &c.

Sand-burned.—Sand partially fused by the heat of the metal and adhering to the casting. This defect is caused by the unsuitable nature of the sand or the want of proper blacking on the mould.

Scoring.—The bursting or splitting of a casting due to strain in contraction.

Scrap-iron.—The spattered masses of iron, wasters, and pieces of iron which have been previously cast.

Shank.—The ladle in which metal is carried from the furnace to the mould. It is managed by a straight bar at one end, and a cross bar with handles, called the crutch, at the other end, by which it is tipped to pour the metal. Shanks are made in various sizes, from those handled by two men to those slung from a crane, and often capable of containing several tons of metal.

Shovel. — The implement for heaping sand into the flask.

Shrinkage.—The contraction of molten metals on cooling. Patterns are always made larger in all their dimensions than the finished castings are required to be. Iron shrinks from one-sixteenth of an inch to one-eighth of an inch per foot; brass about five-thirty-seconds of an inch; bismuth about the same; zinc and lead about five-tenths of an inch per foot; copper three-sixteenths of an inch per foot; tin about one-fourth of an inch per foot.

Shrinking-head.—A body of metal in the gate of a mould to supply the casting with metal during shrinkage. Similar to a riser.

Shutter.—A spade-shaped implement by which the moulder stops the flow into the mould in casting direct from the furnace. By stopping the metal at the ingate, the founder can allow the sow to become sufficiently full, and the metal to attain the right temperature, before he allows it to run into the mould.

Sieve.—A wire-cloth sifter for distributing the sand over the pattern.

Skimmer.—A bar to keep back slag and dross when pouring from the ladle. That part which comes in contact with the molten metal is protected by loam.

Slag.—A basic silicate of iron floating on the metal in the furnace or ladle, and which it is the business of the skimmer to push back in pouring.

Sleeker.—A small polished tool for smoothing surfaces of sand in the mould.

Sow.—A main channel in the floor of the foundry to hold metal when heavy castings are to be made without the use of the ladle.

Spill-trough.—The trough against which the inclined flask

rests when the metal is poured. Any metal spilt from the crucible is caught in the spill-trough.

Spray.—A set of castings attached by their individual sprues to the main runner.

Sprue.—The piece of metal attached to a casting occupying the runner through which the metal was poured.

Stalk.—An iron rod furnished with spikes to form the centre of a core.

Staple.—A piece of iron driven into the sand, and projecting therefrom to hold a core.

Steady-pin.—One of the dowel-pins which form a part of the locking device securing together the parts of a flask; there being usually three or four pins in one part of a flask, which, by fitting into the lugs of the other, enable the two parts to be restored to their original position after the pattern is withdrawn from the mould. The same term is applied to dowel pins used to hold different parts of a pattern together.

Stopping-off.—A term applied to the filling-up with sand of a portion of a mould when a casting is desired without counterpart of, or smaller than, the pattern from which the mould is formed.

Stove.—The drying-chamber for moulds and cores.

Strickle.—A straight edge used to remove superfluous sand from a flask after ramming up. Also, a piece of wood used in loam-moulding.

Strike.—The same as strickle.

Strong-sand.—Tenacious from abundance of clay.

Sullage.—The scum, slag, scoria, dross floating on metal.

Sullage-piece.—An additional length on the upper end of a casting to ensure compactness of the lower part. The scum rises into the sullage-piece, which is afterwards removed.

Swab.—A soft brush of frayed rope, used in wetting the

parting-edge before drawing the pattern, and also to moisten parts of the mould requiring repairs.

Swab-pot.—An iron vessel to hold water for the swab.

Tap-hole.—The opening from which iron flows from the cupola. It is stopped by a bot.

Tapping-bar.—One for opening the tap-hole by removing the bot of clay.

Teaming.—The term used for the operation of pouring molten steel.

Tedge.—The ingate or aperture in a mould through which the metal is poured. The metal which hardens in the tedge is a sprue or waster.

Tumbling-box.—A contrivance for cleaning castings and grinding or polishing small articles by attrition. It consists usually of a cylindrical or barrel-shaped receptacle mounted on an axis and provided with a door for the introduction of the work. Some materials, as slag, cinders, sand, emery, plumbago, scraps of leather, &c., according to the work required to be operated upon, are put in the box with the castings and the whole revolved by a winch or pulley.

Thickness.—The portion of loam, in loam-moulding, which represents the object to be cast, and which is removed before pouring.

Trestles.—Frames on which the perforated core-barrels rest in pipe-moulding. Used with the loam-board, they form a crude sort of lathe, which answers the purpose fully.

Trowel.—Implements of various forms and dimensions used in slicking and parting sand in the mould.

Under-cut.—The parts of a pattern in which the sand would be broken by drawing the pattern perpendicularly. The difficulty is avoided by cores, draw-backs, or an additional part to the flask.

Vent.—A channel by which air escapes from the mould.

Vent-wire.—A sharp-pointed steel wire for piercing sand in the mould to allow escape of air.

Waster.—A spoiled casting which goes to the scrap-heap for remelting.

Watering-can.—One with a rose to damp the moulding-sand.

Weighting.—Blocks put on a flask to keep the cope down under the upward pressure of the body of iron poured into the mould.

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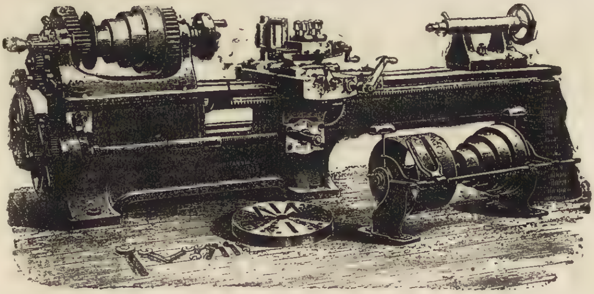

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